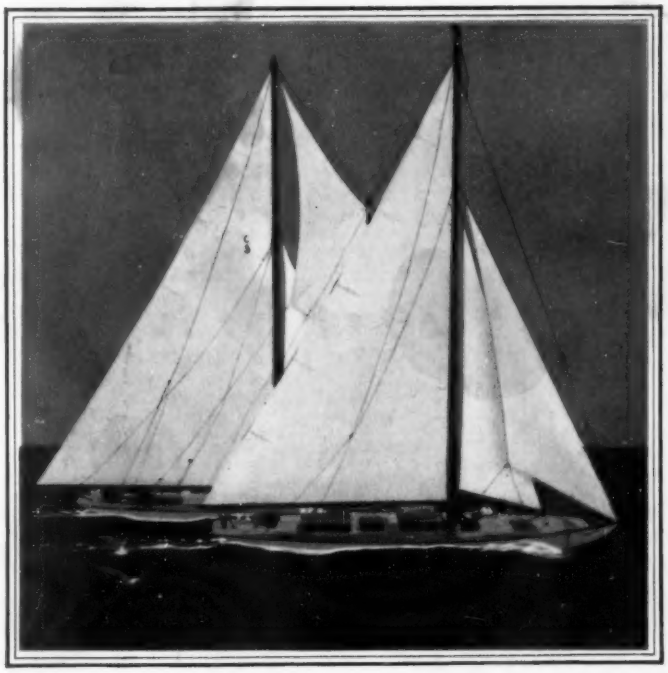
SCIENTIFIC AMERICAN

SEPTEMBER 1927 ★ *Thirty-five Cents a Copy*



SLEEPY SICKNESS

BY DR. SIMON FLEXNER

TELEPATHY—FACT OR FABLE?

WHY FLY WITHOUT RADIO?

30 DAYS FREE TRIAL

7 Tube Set
Single Dial Radio

Metrodyne Radio Sets
Are Equipped For
BATTERY or ELECTRIC operation

The Metrodyne
ONLY ONE DIAL TO TUNE

RETAIL PRICE
$75.00
Completely Assembled
Big Discounts to Agents and Dealers

Wonderful offer direct from the factory! The world's greatest radio! A perfect working, single dial control, 7 tube receiver! And just to prove our claims, we will ship it to your home for **30 days' free trial.** Test it under all conditions. Test it for distance, volume and tonal quality—and if you are not convinced that it is the **best single dial set** you ever heard, return it to the factory. We don't want your money unless you are completely satisfied.

Three Year Guarantee

BIG PROFITS TO AGENTS AND DEALERS

Our Agents and Dealers make big money selling Metrodyne Sets. You can work all or part time. Demonstrate the superiority of Metrodynes right in your home. Metrodyne Radios have no competition. Lowest wholesale prices. Demonstrating set on 30 days' free trial. Greatest money-making opportunity. Send coupon, a letter or a postal for our agent's proposition.

Metrodyne Super-Seven Radio

A single dial control, 7 tube, tuned radio frequency set. **Tested and approved by Popular Science Institute of Standards, Popular Radio Laboratory, Radio News Laboratory** and by **America's leading Radio Engineers.** Designed and built by radio experts. Only the highest quality low loss parts are used. Magnificent, two-tone walnut cabinet with beautiful, gilt metal trimmings. Very newest 1928 model, embodying all the latest refinements.

Easiest set to operate. Only one small knob tunes in all stations. The dial is electrically lighted so that you can log stations in the dark. The volume control regulates the reception from a faint whisper to thunderous volume, **1,000 to 3,000 miles on loud speaker!** The Metrodyne Super-Seven is a beautiful and efficient receiver, and we are so sure that you will be delighted with it, that we make this liberal **30 days' free trial offer.** You to be the judge.

6 Tube Set
$48.50
RETAIL PRICE
Completely Assembled

30 Days' Free Trial—3 Year Guarantee

Metrodyne Super-Six

Another triumph in radio. Here's the new 1928 model Metrodyne 6 tube, two dial, long distance tuned radio frequency receiving set. Approved by leading radio engineers of America. Highest grade low loss parts, completely assembled in a beautiful walnut cabinet. Easy to operate. Dials easily logged. Tune in your favorite station on same dial readings every time — no guessing.

Mr. Howard, of Chicago, said: "While five Chicago broadcasting stations were on the air I tuned in seventeen out-of-town stations, including New York and San Francisco, on my loud speaker horn, very loud and clear, as though they were all in Chicago."

We are one of the pioneers of radio. The success of Metrodyne sets is due to our liberal 30 days' free trial offer, which gives you the opportunity of trying before buying. Thousands of Metrodynes have been bought on our liberal free trial basis.

MAIL THIS COUPON
or send a postal or letter. Get our proposition before buying a radio. Deal direct with manufacturer— SAVE MONEY—WRITE NOW!

MAIL COUPON BELOW

Let us send you proof of Metrodyne quality—our 30 days' free trial offer and 3 year guarantee

Mrs. Wm. Leffingwell, Westfield, N. J., writes: "The Metrodyne Radio I bought of you is a wow! This is as good as any $225 machine I have ever seen."

N. M. Greene, Maywood, Ill., writes: "My time is up and the Metrodyne works fine. I got Havana, Cuba, Oakland, Calif., Denver, Colo., Toronto, Canada, all on the loud speaker."

J. W. Woods, Leadville, Colo., writes: "Received the 7-tube Metrodyne in fine condition. Had it up and working same day received. Was soon listening to Los Angeles, San Diego, Oakland and other California points; also St. Louis, Kansas City and other east and south stations—all coming in fine. Am more than pleased. Sure enjoying it."

We will send you hundreds of similar letters from owners who acclaim the Metrodyne as the greatest radio set in the world. A postal, letter or the coupon brings complete information, testimonials, wholesale prices, and our liberal **30 days' free trial offer.**

METRO ELECTRIC COMPANY
2161-71 N. California Ave., Dept. 56
Chicago, Illinois

Gentlemen:

Send me full particulars about Metrodyne 6 tube and 7 tube sets and your **30 days' free trial offer.**

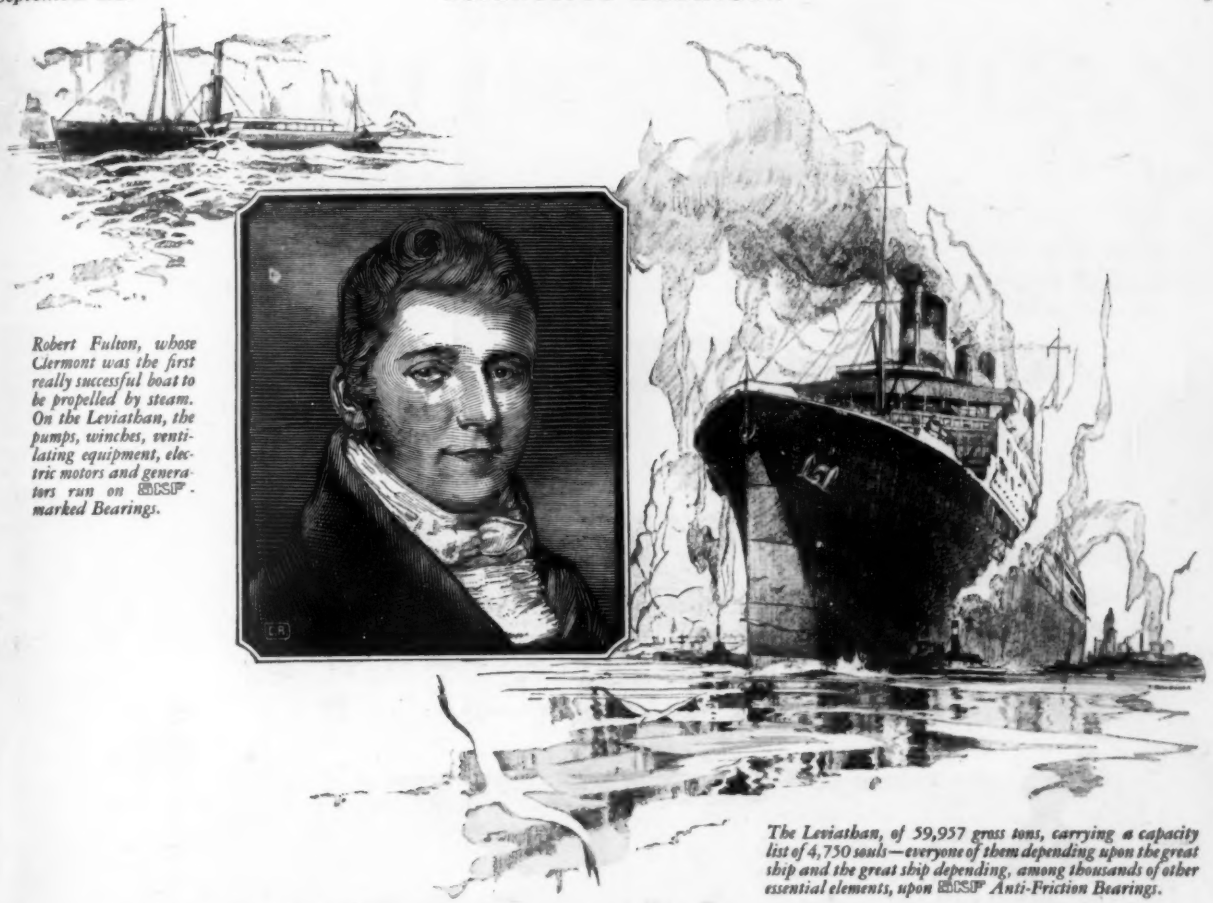
*Name*_____

*Address*_____

If you are interested in AGENT'S proposition, place an "X" in the square ➡ ☐

METRO ELECTRIC COMPANY

2161-71 N. California Ave. • Dept. 56 • Chicago, Illinois



Robert Fulton, whose Clermont was the first really successful boat to be propelled by steam. On the Leviathan, the pumps, winches, ventilating equipment, electric motors and generators run on SKF-marked Bearings.

The Leviathan, of 59,957 gross tons, carrying a capacity list of 4,750 souls—everyone of them depending upon the great ship and the great ship depending, among thousands of other essential elements, upon SKF Anti-Friction Bearings.

DOWN TO THE SEA IN SHIPS

WITH SKF BEARINGS

MORE honor to Fulton, whose genius created the Clermont and whose will overcame the thousands of obstacles that stood in the way of achievement! For, Fulton not only fought against problems that were *known*, but he fought against one problem that practically was unknown. He fought against FRICTION in every turning wheel of his wheezing engine and in the ponderous paddles that drove the Clermont on its sluggish way!

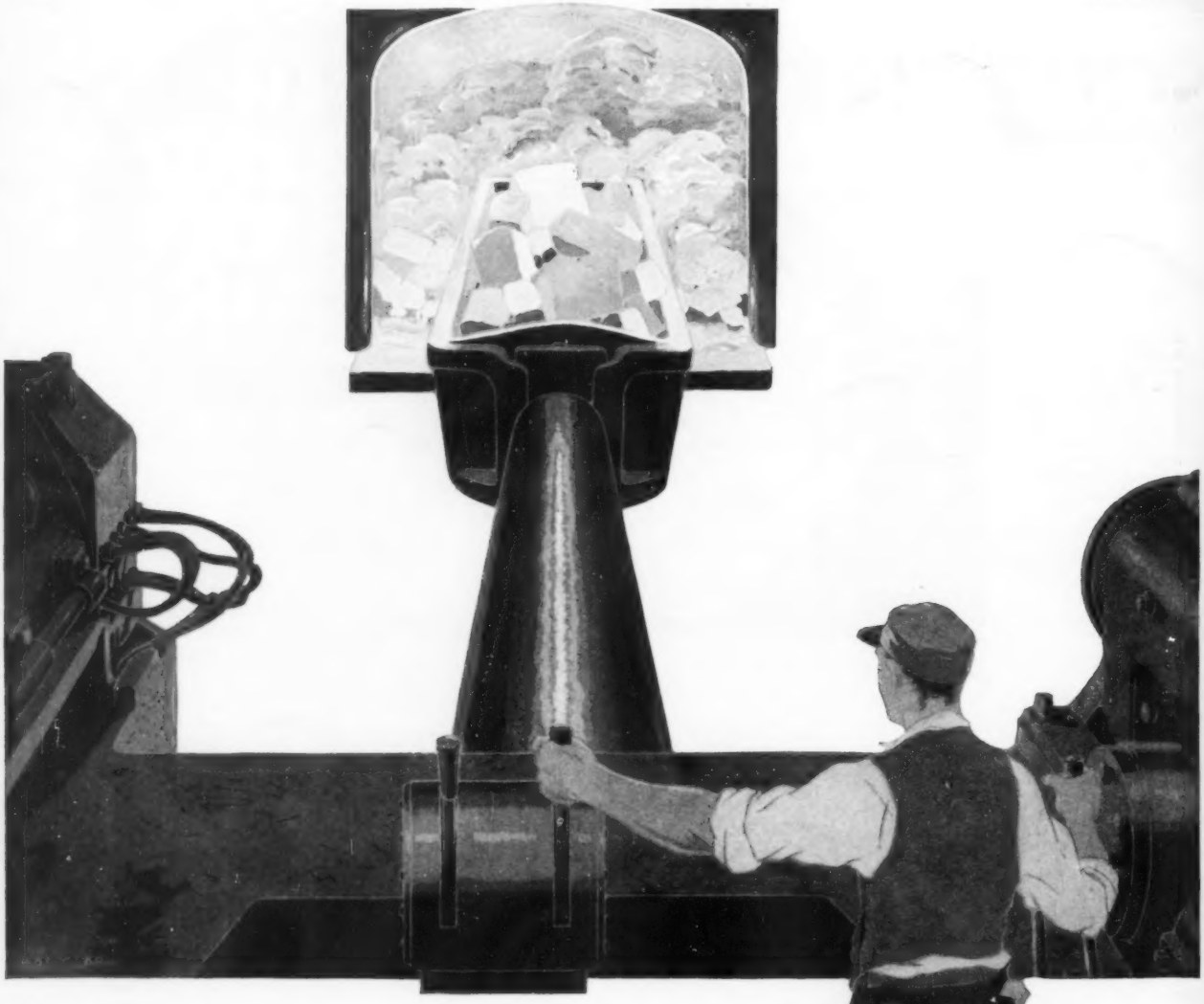
Today, the great ships that go down to the sea are almost as completely equipped with SKF-marked Anti-Friction Bearings, as the biggest industrial plant ashore. Their electric motors and generators turn on SKF-marked Bearings. Their great pumps and winches, their all-important ventilating systems and, on some ships, the main drive shafts, are SKF-equipped. Many U. S. Engineer Corps dredges depend on SKF Bearings to keep pumps going. One eight-foot dredge pump has established a world's record for pumping.

There are no service stations along the great water routes that ships travel. The bearings MUST be dependable and that, according to those responsible for even such ships as the great Leviathan, means SKF.

SKF is a world-wide organization of men, mines and plants that specializes on anti-friction bearings. No matter what your bearing problem may be, put it up to SKF.

SKF INDUSTRIES, Inc. 40 East 34th Street New York City

1811



The Engineering Check on Your Motor Car

Long, safe, economical, trouble-free service—that is what you want from your car. One of the best ways to be certain of getting it is to make sure that Timken Tapered Roller Bearings are used in the important units.

Only Timken Bearings—with their exclusive combination of Timken-made Electric Steel, Timken tapered construction and Timken *POSITIVELY ALIGNED ROLLS*—provide for *all* the forces of side-thrust, shock, speed, weight, torque and friction.

In cars, trucks and buses Timken Tapered Roller Bearings permanently silence and wear-proof the transmissions, differentials, pinions or worm drives, rear wheels, front wheels, steering pivots and fans.

How well, how long, and how economically a car will serve you is infallibly indicated by the presence of Timken Bearings. Look for them when you are looking for greatest value.

THE TIMKEN ROLLER BEARING CO.
C A N T O N , O H I O

CHARGING TIMKEN ELECTRIC FURNACES MECHANICALLY WITH TIMKEN - EQUIPPED MACHINERY. In the Timken Steel Mill, as in every other great industry, Timken Bearings receive severe tests. In every-day service Timken and other steel manufacturers use Timken Bearings to carry loads of 1,500,000 pounds and more. In precision machine tools Timken Bearings are used for speeds up to 15,000 revolutions per minute. Throughout Industry Timkens are known for power savings up to 60%, even greater lubrication savings, and endurance never before thought possible.

TIMKEN *Tapered Roller* **BEARINGS**

Scientific American, September, 1927, Vol. 137, No. 3, entered at the New York, N. Y., Post Office as Second Class Matter June 28th, 1879, under the Act of March 3rd, 1879; additional entry at Dunellen, N. J. Published Monthly by Scientific American Publishing Co., 24 West 40th Street, New York City. Copyright 1927 by Scientific American Publishing Co. Great Britain Rights Reserved. Subscription Price $4.00 per year

SCIENTIFIC AMERICAN

September 1927 *Edited by* ORSON D. MUNN Eighty-third Year

Flood

POSSIBLY 77,777,777 bright ideas, more or less, for preventing any more Mississippi flood disasters have been made. Most of them center about levees, reservoirs, reforestation, and new spillways. The odd thing is that most of these good people, who seem to have just become conscious of the problem this year, assume that the army engineers who have had charge of the job for decades have never even given these ideas a systematic canvass.

Of all the "bright" ideas, the "brightest" is the proposal to dig a parallel river channel all the way down river—double tracking the Mississippi, as it were. If we had this it would be fine. But by the way, it would cost, according to a statement in the *Engineering News-Record*, some 189,838,537,778 dollars—a mere trifle, of course.

Still, all these wild proposals are not a circumstance to those we shall hear next December when Congress meets.

Vast

"IS this not just another impracticable scheme?" "Is it really important?" In the July issue we devoted most of the Digest Department to a consideration of the proposed process for the liquifaction of coal, a method of turning coal into fuels like gasoline. A few of our readers remain incredulous about the assumed great significance of this new discovery.

We think it is likely to prove of tremendous importance. A. C. Fieldner, Chief Chemist of the United States Bureau of Mines, writing in the *Tech Engineering News*, points out its potentialities. We have a reserve of five billion barrels of petroleum, which undiscovered methods of recovery may increase to 26 million barrels, Our oil-shale deposits, not yet touched, contain 108 billion barrels, truly a vast reserve.

But compare even these stupendous figures with the potential liquid-fuel reserves contained in our lignite and coal resources, if the new liquefaction processes are brought to bear on it. There would be 595 billion barrels! This in a nutshell shows why we are watching with keen interest the newest developments in the liquefaction of coal.

Hoboes

THE Denver and Rio Grande Railroad has found a new way to deal with hoboes that ride freight trains. When they catch one they collar him and steer him to the nearest ticket office where they make him purchase a regular full fare ticket from the point at which he boarded the train. Last year they did this to 28,488 hoboes and extracted from them 18,393 dollars.

The railroad says the hoboes are influenced by the advertising of scenic attractions in the Rocky Mountains, in the same way as regular passengers!

We suppose the railroad is right about making these hoboes pay their fare. Yet, somehow we entertain a lingering sympathy for the poor hobo. On closer self-examination we discover the reason: some years ago—seventeen, to be exact—the writer of this note had a delightful hobo experience himself; he "hopped freights," ate occasionally, worked none. And today he remains loyal to the profession! What he *can't* figure out is, how these hoboes managed to dig up 18,393 dollars. Times must be better nowadays.

Currency

WITH the mortality rate of our paper money increasing at an alarming rate, the Treasury Department has determined to resort to amputation. The use of paper money has trebled in the last fifteen years; a dollar bill used to be good for twenty months; now it is worn out in six. Every year the Bureau of Engraving and Printing finds itself printing a billion new bills.

Cutting down the number of pieces of paper money would solve the problem, but we need all the bills we can get—and more. Why not, then, cut down each bill? It is not what it used to be in purchasing power, anyway. And looking over the advantages it will bring, such a move seems eminently worth while. It will save 2,000,000 dollars annually, it will solve the Bureau's problems, and it will be more convenient when once the public gets accustomed to the new size.

To the new size dollar bills—and the fives, tens and twenties, too—we extend a welcome. May we see lots of them!

Cover

THE two 75-foot yachts shown on our cover are attracting more attention among the racing yachtsmen than any yacht, big or little, of the present season. In the foreground is the 75-foot sloop *Katoura*, built this year. She carries the Marconi rig, and resembles the little 6-meter sloops. Abreast of her is the schooner *Vanitie*.

CONTENTS

SEPTEMBER 1927

The Hudson River Vehicular Tunnel—*By J. Bernard Walker* 201
The Invention of Human Speech—*By Sir Richard Paget* 204
Our Point of View—Editorial 206
Flyer Equipped for High-Altitude Work 207
Odd Stars—*By Prof. Henry Norris Russell* 208
Specimens from the Telepathic Mine—*By Walter Franklin Prince, Ph.D.* 210
The June 29th Solar Eclipse in England 214
A Frenchman's Motor Caravan, a Home on Wheels 215
Power Plant to Generate 1,000,000 Kilowatts 216
The Month in Medical Science—*By Morris Fishbein, M.D.* 218
Ice that Melts to a Gas—*By D. H. Killeffer* 220
Building an Airport With Dredges 223
Sleepy Sickness—*By Simon Flexner, M.D.* 224
Why Fly Without Radio?—*By Orrin E. Dunlap, Jr.* 226
Sloop versus Schooner 229
Dawn-Man or Ape?—*By Prof. William K. Gregory* 230
Extracting Snake Venom For Use In Serums 233
Sounds Recorded on "Movie" Film—*By A. P. Peck* 234
World's Largest Artificial Lake 237
The City of the Future—*By Ernest Flagg* 238
Successful Inventors—IX—*By Milton Wright* 242
The Most Fascinating Spot on Earth—III—*By D. Moreau Barringer, Jr.* 244
What Determines Rowing Speed?—*By Lewis Hobart Kenney, M.E.* 247
From the Scrap-Book of Science—Camera Shots of Scientific Events 250
Inventions New and Interesting 252
Household Inventions 253

DEPARTMENTS

Scientific American Digest 254
Learning to Use Our Wings 256
Radio Notes 260
Industries From Atoms 262
Applied Science for the Amateur 264
The Heavens in September 274
In the Editor's Mail—Where Reader Meets Reader 279
Commercial Property News 285
Patents Recently Issued 285

LOS ANGELES Harbor Exports Increase 100-Fold in 10 Years!

Exports Increased from $748,000 in 1915 to $111,938,391 for the Year Ending June 30, 1927.

RAW MATERIALS and markets of the world are brought to the door of the Los Angeles County manufacturer by 151 steamship lines.

The rapid growth of Los Angeles harbor as a world port, the many natural manufacturing advantages of Los Angeles County, and an immediate market of tremendous buying power have created here the West's largest industrial community.

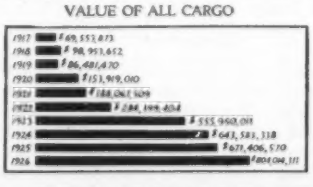
During 1926 some 300 new industries established here. In the first half of 1927 such nationally known concerns as B. F. Goodrich Rubber Company, Sears, Roebuck & Company, Illinois Glass Company, S. Karpen & Bros., Truscon Steel Company, with an aggregate plant investment of $12,000,000, have located in Los Angeles County.

For specific information, address the Industrial Department of the Los Angeles Chamber of Commerce.

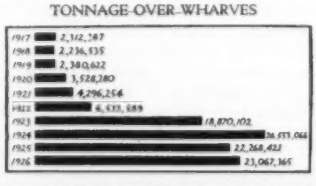
Favorable Factors that Attract Industries

Large local markets.
Industrial Freedom.
Power as low as .72 of 1 cent per K. W. H.
Abundant cheap water.
Natural Gas and Oil Fuel at 20c and 16 1-8c respectively per million B. T. U's.
Climate for 100% labor and plant efficiency and low plant investment.
3 trans-continental railroads.

VALUE OF ALL CARGO



TONNAGE-OVER-WHARVES



·INDUSTRIAL·LOS·ANGELES·

Among our Contributors

DR. SIMON FLEXNER

Since 1903, Dr. Flexner has been Director of the world-famed laboratories of the Rockefeller Institute for Medical Research. In this remarkable institution, under Dr. Flexner's direction, research work of the highest value to humanity has been and is continually being performed. On page 224, Dr. Flexner writes about one of the problems of medicine that is yet unsolved.

DR. WALTER FRANKLIN PRINCE

Dr. Prince's name has often figured prominently in the newspapers in connection with famous psychic investigations. It is pretty hard to make anything like an exact science of an intangible subject like abnormal psychology, yet those who, in reading his article on mind reading (page 210), suspect Dr. Prince of always favoring the psychic side would be surprised to know how often he has favored the other side.

Sir Richard Paget

The author of the article on the invention of human speech (page 204) is a British lawyer who specializes in the development of inventions. His recreations are music, acoustics, arts and crafts. He has performed some extremely interesting experiments on reproduction of human speech, and has literally made a real "talking machine."

Ernest Flagg

The author of the intriguing article on an ideally planned city (see page 238) is the well known architect of the Singer Tower in New York and the United States Naval Academy at Annapolis, as well as the Corcoran Gallery of Art in Washington. He tells us how living and business conditions can be enormously improved.

Prof. William K. Gregory

Among students of evolution, Professor Gregory, who contributes a lucid article on the controversy about man's ape ancestry, is known as one of a possible half dozen of the world's best supports in matters of organic evolution, where anatomy is involved. Especially is Dr. Gregory known to possess a judicial mind in things scientific.

D. H. Killeffer

The author of the article about "dry ice" (frozen carbon dioxide) on page 220, is not only Chemical Editor of the SCIENTIFIC AMERICAN but Associate Editor of *Industrial and Engineering Chemistry*, the foremost American journal of chemistry and the publication selected as the official organ of the great American Chemical Society.

Looking Ahead

with the Editor

RATTLESNAKES

How one of the most peculiar ranches in the world—a rattlesnake ranch—is run will be told. The venom extracted from the snakes' fangs is regularly "milked" for serum-making. Running such a ranch is fascinating—to read about!

TROGLODYTES

In northern Africa, in the desert country 300 miles south of ancient Carthage, 30,000 people live in wells—circular holes in the ground. They seldom "come up for air" except when they die, when they are buried nearer the surface than they have lived! The peculiar life they lead will be described by Horace Ashton, Fellow of the Royal Geographical Society.

MOLECULES

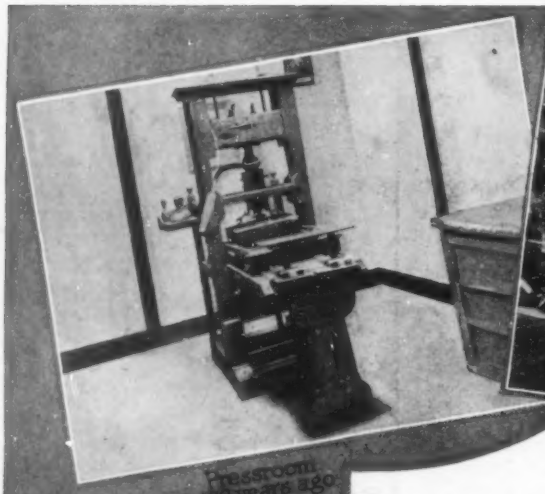
A whimsical writer might say that the atom, and more recently the electron, have received so much attention of late years that the poor molecule has almost been forgotten. In an early issue Prof. S. R. Williams of Amherst College will give the molecule a chance to prove itself as interesting as the atom and the electron.

DODO

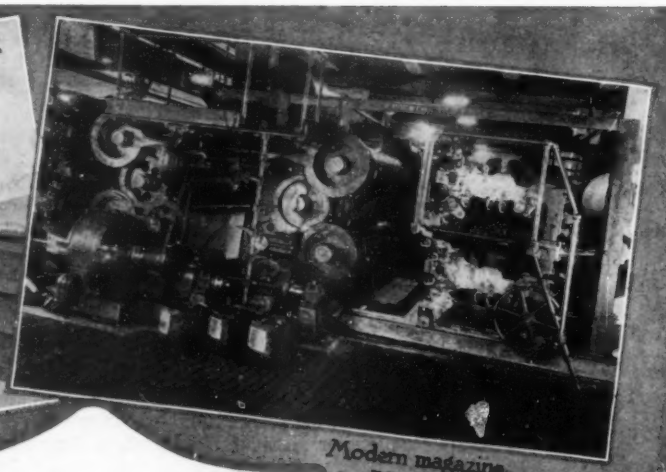
The dodo bird is extinct—everybody says "as extinct as the dodo," now and then—and so is the famous passenger pigeon. Man came and bludgeoned, killed them all, and seemed satisfied. Are the other birds similarly doomed? Read "Conservation or Extinction?" by Prof. Leon A. Hausmann, noted ornithologist, next month.

400,000,000

That is the aggregate horsepower developed by the 20,000,000 motor cars in the United States. Quite a power plant, isn't it? How the engines of these motor vehicles are tested forms the subject of a most informative article by Prof. Lockwood of Yale.



Pressroom 100 years ago



Modern magazine pressroom

GRINDING—PRINTING

Could the old-time type setter glimpse his followers, the monotype and the linotype—

and the printer of Ben Franklin's day gaze upon the monstrous high speed printing presses of today—

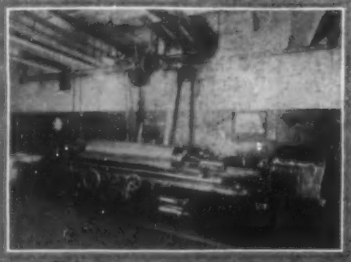
and could they realize the accuracy requirements in steel rolls that produce the modern printer's ink—

Then they'd appreciate the part that Grinding takes in the printing industry—in making practical through swift, accurate, economical manufacture the myriad of fast moving parts in the mechanical workers of today.

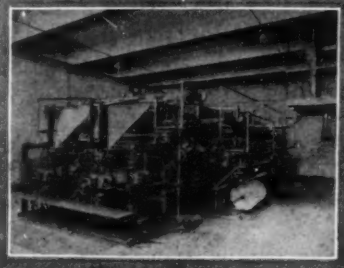
NORTON COMPANY
Worcester Massachusetts

Hand composition

Monotype composition



Grinding rotogravure roll



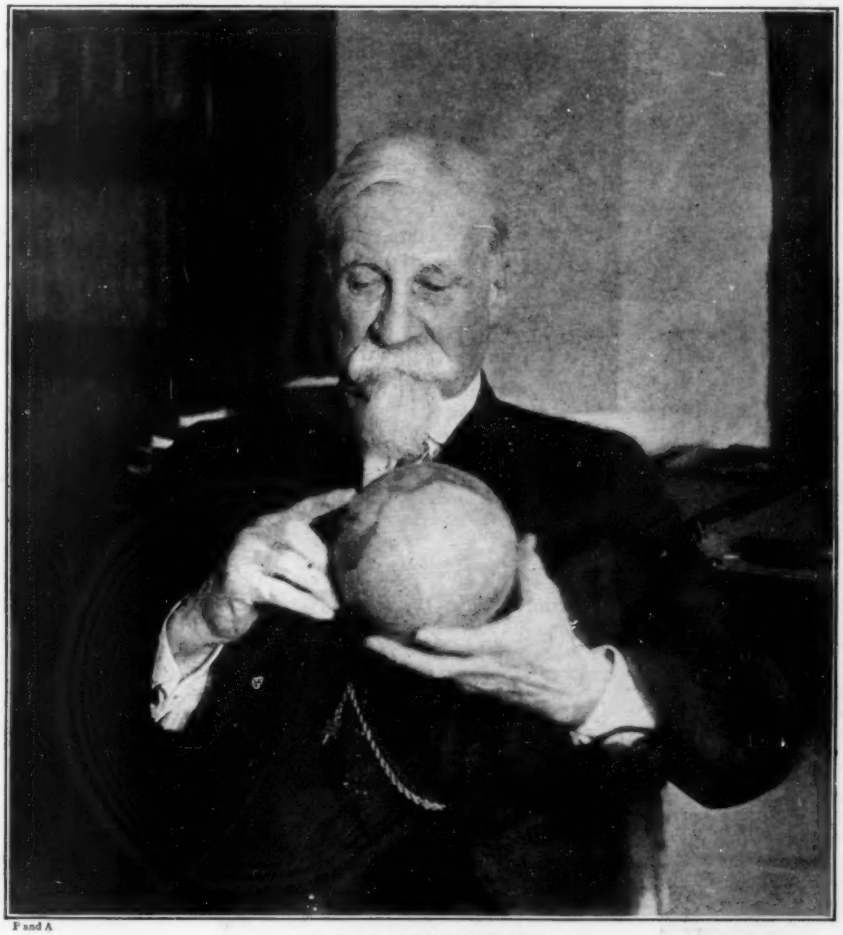
Making printers' rule

Grinding ink roll

TRADE NORTON MARK

Grinding Wheels-Grinding Machines-Refractories-Floor and Stair Tiles

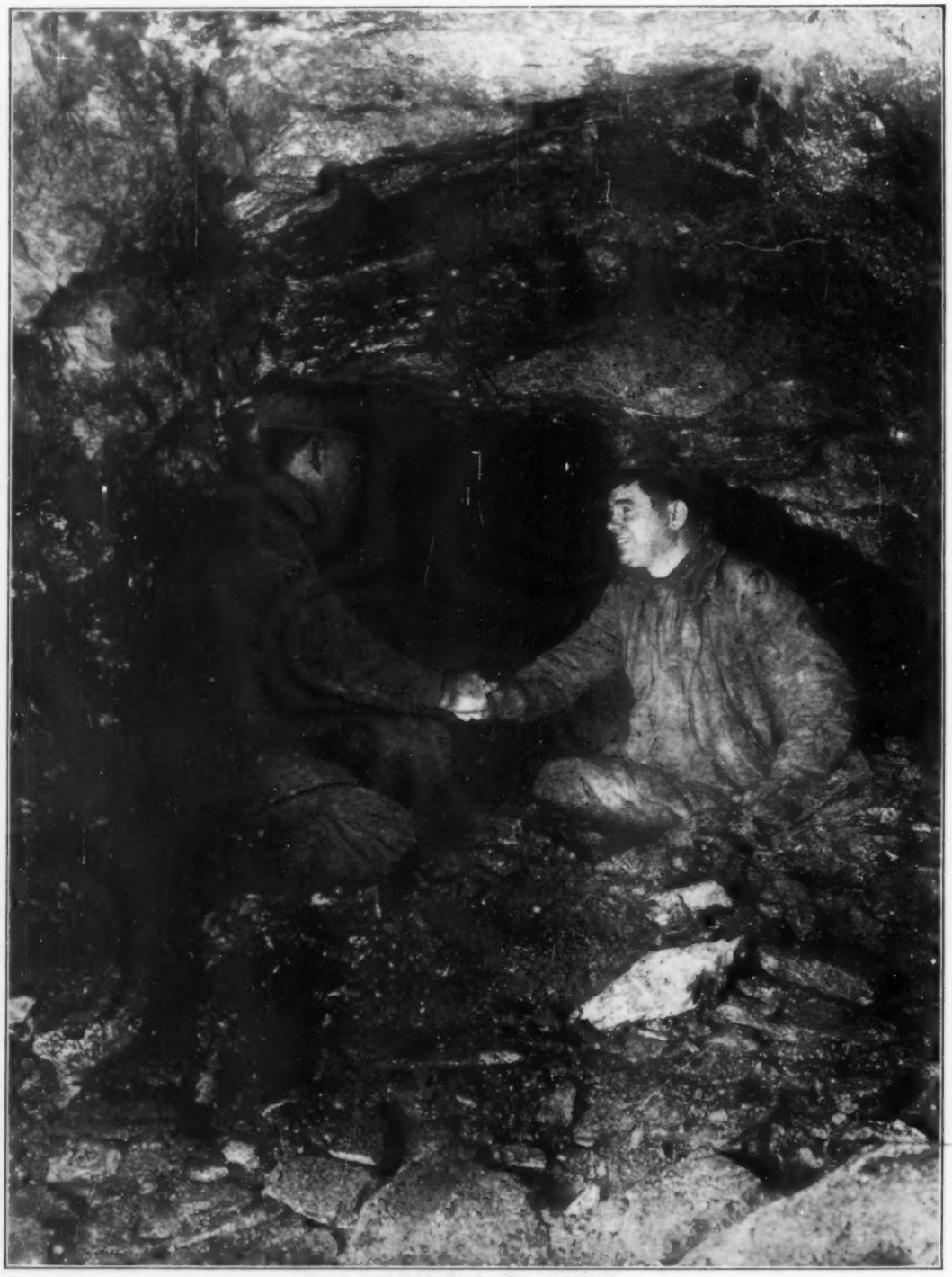
NORTON



F and A

DR. T. C. CHAMBERLIN

By common consent among scientists, Professor Chamberlin of the University of Chicago, strong and well in his 85th year, is the dean of American geologists. Specifically he is best known as a cosmologist, the famous Chamberlin-Moulton "Planetesimal Hypothesis" of the origin of the planets, announced in 1899, having in some form entirely superseded the old classic "Nebular Hypothesis" of Kant and Laplace. It asserts that the matter of which the planets are formed was torn from the sun by the attraction of a passing star. This matter, in the form of comparatively small, solid bodies called "planetesimals," gathered in "knots" which, as they grew, became planets. The hypothesis is explained in "The Origin of the Earth," by Dr. Chamberlin. Several modifications of the original Chamberlin cosmology have more recently won adherents, notably that of Professor Jeans of Cambridge University, that of Dr. Harold Jeffreys, also of Cambridge, and that of the late Professor Barrell of Yale. These are molten-earth theories, while Chamberlin's is a cold-earth theory. The fact that these newer modifications have been quite accepted by scientists has tended to obscure the main fact that the theory as a whole, involving an immensely important turning point in modern cosmology, is the epoch-making concept of Professor Chamberlin, and that the newer theories agree with his original theory in perhaps nine tenths of their main details



"Holing Through" the Hudson Vehicular Tunnel

The great vehicular tunnel between New York and New Jersey is to be known officially as the Holland Tunnel, in honor of its first Chief Engineer, the late Clifford M. Holland. It consists of two separate, parallel tunnels, one for eastbound, the other for westbound traffic. They are the largest in existence, the outer diameter, measured over the cast-iron shell, being 29½ feet. The roadways, 20 feet wide, will each accommodate two lines of vehicles. The tunnels are 8500 feet in length.

THE FINISHED TUNNEL

At the center of the river looking toward New Jersey. The roadway, 20 feet wide, accommodates two lines of vehicles, moving east. Note openings in roof, through which foul air enters duct above

The Hudson River Vehicular Tunnel

A Big Problem of Ventilation, Requiring Nearly Four Million Cubic Feet of Fresh Air Per Minute

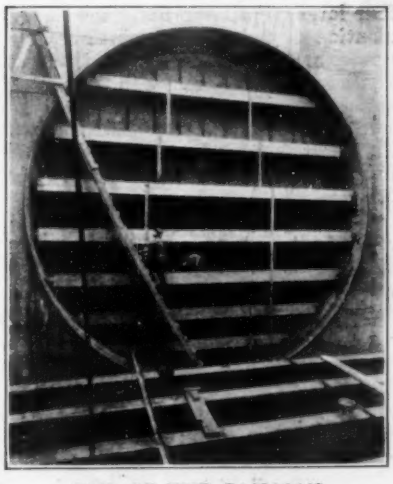
By J. BERNARD WALKER

THE opening of the great tunnels for the exclusive use of automotive vehicles beneath the Hudson River is an event of prime importance in the world of civil engineering; for not only in respect of its diameter and capacity is this the greatest tunnel in the world, but it called for an absolutely sure solution of an unprecedented problem of ventilation, since each tunnel would receive the exhaust gases of 1900 vehicles per hour. No such problem of ventilation, either in magnitude or character, has ever presented itself.

THERE are other vehicular tunnels in Europe and mainly in London, but they are much shorter, have a smaller traffic capacity, and hitherto they have handled a very large percentage of horse-drawn vehicles, sufficient ventilation being afforded by the natural draft through the portal openings.

The problem was investigated under three subdivisions: first, the amount and composition of exhaust gases; second, the physiological effect of these gases; and third, the best method of ventilation. The danger to be guarded against was an excess of carbon monoxide. It was realized that the amount of this given out in the exhaust must be definitely determined. There was no exact information on the subject, and, accordingly, under cooperative agreement between the New York-New Jersey Tunnel Commission and the United States Bureau of Mines, the Bureau undertook to carry out the necessary investigations. Here were made some 2000 tests on more than 100 types and sizes of motor vehicles. From these tests, the amount and composition of the exhaust gases from engines being operated under ordinary road conditions were established.

The tests to determine the physiological effects on individuals were performed at Yale University, and here it was determined that, if the poisonous carbon monoxide was kept down to four parts in 10,000 parts of air, the air would be entirely satisfactory for an exposure of one hour. Since a car would take only about ten minutes and a truck about 15 minutes to pass through the tunnel, this would provide ample safety.

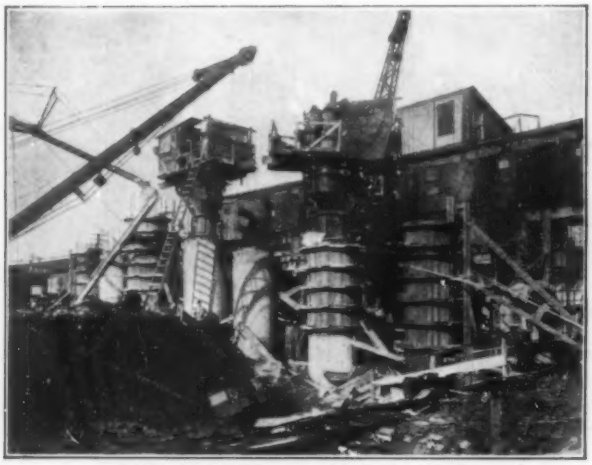


ONE OF THE CAISSONS

Note relative size of man and caisson. Diaphragm was removed and shield entered the silt of the river bottom

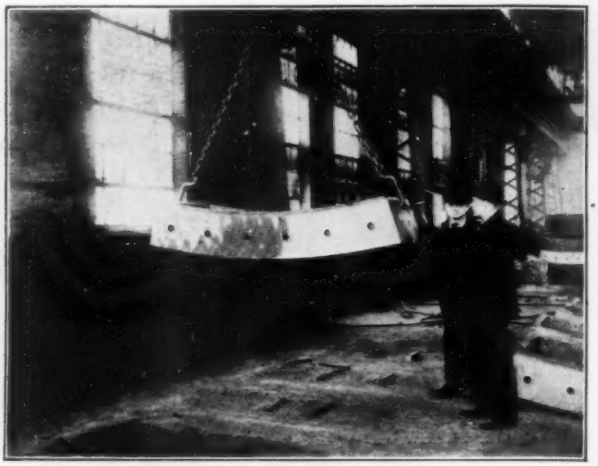
A third series of tests to determine the best method of ventilation and the power necessary to accomplish it, was carried through on the campus of the University of Illinois in a concrete tunnel, served by a fan having a capacity of over 100,000 cubic feet per minute. The frictional losses in the concrete tunnel were determined, the air being taken off and entering at intervals such as would occur in the actual tunnel.

THE engineers of the tunnel now felt that the three questions of the amount of exhaust gases, their effect on the users of the tunnel, and the best method of ventilation, had been satisfactorily answered. Nevertheless, in order to be absolutely sure, they decided to demonstrate the proposed method of ventilation in a model tunnel. This work was done by the Bureau of Mines. A tunnel, whose cross-section was about one-third that of the Holland tunnel, was constructed



SINKING PILE CAISSONS TO ROCK

Eighty-four of these steel concrete piles were sunk to rock, 260 feet below surface. They carry a ventilating building



A MASSIVE TUNNEL SEGMENT

The tunnel is lined with machined cast-iron and cast-steel segments. These are held firmly together by alloy-steel bolts

in the Bureau's experimental mine at Bruceton, Pennsylvania. In each test eight automobiles were driven on the experimental roadway for a period of one hour, and during this time the air was sampled in various ways. Temperature and humidity readings were taken, and physiological tests were made on over 50 people who took part in the tests. There was for a time a division of opinion as to the best way to introduce the fresh air and take out the contaminated air from the tunnel, many people believing that the gases should be taken off at the roadway where they exhausted from the engine. Although this seemed plausible, the Bruceton tests definitely established that better results were obtained by introducing the fresh air at the bottom, and drawing the vitiated air off at the roof of the tunnel.

Just here we wish to state that this great thoroughfare below the Hudson is to be known as the Holland Tunnel in memory of the late Clifford M. Holland who, as chief engineer, organized the engineering staff, worked out the elaborate plans for the tunnel, and carried them successfully through in the earlier years of its construction.

For the data and photographs which accompany this article, we are indebted to the present chief engineer, Mr. Ole Singstad, who has completed the work.

THE ventilating plant, as will be readily understood, is of large capacity, and has called for the installation of four ventilation stations, one in the Erie Railroad yard, near the Jersey City end of the tunnels, one in the river, near the New Jersey pier-head line, one near the pier-head line, New York, and one at Washington Street near the New York terminal.

The traffic runs in one direction only in each tunnel. The fan equipment for driving the fresh air into the tunnel and exhausting the vitiated air is installed in each of the four large ventilator buildings above mentioned, and each set ventilates the tunnel half-way, each way, to the next ventilating building. The fresh air enters through louvered openings in the sides of the building and passes down the shaft to the duct which extends below the roadway, from which it enters the roadway just above its surface.

The circular tunnel is divided by two continuous diaphragms into three separate parts. At the center is the roadway section, which is 13 feet, six inches in height. Above and below are the air ducts, each of which, like the roadway section, is continuous from end to end of the tunnel. The air is forced by the fans continuously into the lower fresh-air duct, from which it passes on to the tunnel roadway through a continuous chamber on each side.

The chamber has a continuous steel plate in front of it, which leaves a slot opening, varying in width from three-fourths to one and three-fourths inches. These slots are arranged so that there is a continuous stream of fresh air entering the tunnel at the roadway level on each side throughout its entire length. This air mixes with the exhaust gases and they gradually rise and pass through openings leading into the exhaust duct above.

In order to insure a dilution in which carbon monoxide will not exceed four parts in 10,000, 3,761,000 cubic feet per minute of fresh air have to be introduced.

The fans are driven by alternating current motors, and their capacity varies from 81,000 to 220,000 cubic feet per minute, this variation being due to the different lengths and areas of duct to be served. Thus the fans ventilating the tunnel from the river shaft half-way up to the land shaft ventilate only 750 feet of tunnel, while the fans in the ventilating building on the opposite side of the river ventilate

TIGHTENING LINING BOLTS

The tunnel is remarkably watertight. These men, using a ratchet wrench, are bringing segments to a tight bearing

GROUTING THE TUNNEL

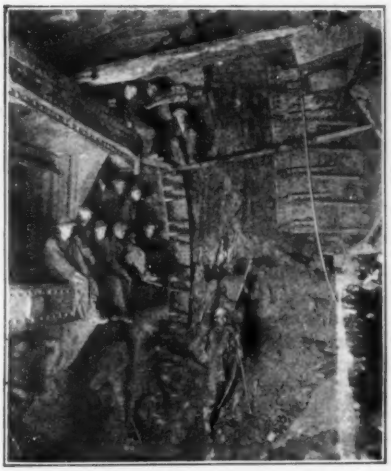
Liquid cement is driven through the cast-iron shell to close the voids between it and the surrounding sand or silt

over 1700 feet. It will take about 4000 horsepower to ventilate the tunnel at maximum capacity. There will be no high-velocity air current in the tunnel, although its atmosphere undergoes a complete change every one and one-half minutes. The air-stream comes out through the side slots so gently that five feet away your hand cannot feel the movement.

The chief engineer, Mr. Singstad, is of the opinion that this is the only really safe method of ventilation, judged from a fire hazard point of view. If a swift air current were blown through, and one of the motor cars caught fire, the flames might spread from one vehicle to the next and the draft would carry the smoke through the tunnel so that conditions would be unsafe, and there would be danger of panic. In the demonstration with smoke bombs at the experimental tunnel, it was found that, although the smoke was so dense that the men could not see their hands in front of their faces, the smoke did not spread more than 30 feet on either side of the source of the smoke.

THE tunnels are 8500 feet long between the portals and each has a roadway 20 feet wide with a clear headroom of 13 feet, six inches. The exterior diameter is 29 feet, six inches. The tunnels are lined internally with concrete. The side walls are tiled with a vitreous white tile and the roadways are paved with granite block.

Each tunnel, which is built of segmental, cast-iron rings, was driven through the bed of the river by the well-known shield method. Each ring is 30 inches in width, measured along the length of the tunnel. Some distance to the rear of the shield was a concrete bulkhead, ten feet thick, in which were built four air-locks, of which the two upper locks were used by the men, and the two lower locks for material. Of the upper locks, one was used for the entrance or exit of men, and the other was for emergency, with the door facing towards the shield always open. The portion of the tunnel between this bulkhead and the shield was always under a pressure of air sufficient to hold the water out of the heading. The shield was pushed ahead by hydraulic jacks, each of 200 tons capacity. These used the forward end of the completed tunnel as an abutment.



THE MEETING OF THE SHIELDS

To the left is shown the cutting edge of the New York shield. To the right is the hood of the New Jersey shield

Comtemporaneously with the excavation of the tunnel at the shore ends, large shafts were sunk, as pneumatic caissons, and the bottoms sealed. The shields were erected in the lower part of the caissons, temporary roofs were placed in the latter, and the chambers were put under compressed air. Openings were provided in each wall of the caissons before sinking, which were closed by temporary steel bulkheads. These were later removed and the shields were started on their way under the river. The steel boxes for the river caissons were sunk while the shields were being driven from the land shafts. When the shield approached the caisson, which had already reached its position on the axis of the tunnel, the temporary bulkheads were burned out. The shield was then pushed into and through the caisson, whereupon it continued on its way below the river.

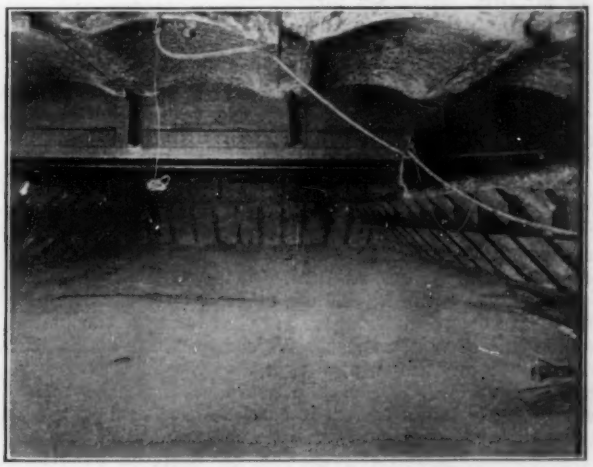
THE sinking of the New Jersey shaft was a most difficult problem. The caisson, 107 feet below water level, was on silt too soft to sustain the ultimate load, and the foundations had to be carried to rock, 260 feet below water level. This was done by sinking 84 steel-shell reinforced concrete piles, each 24 inches in diameter and 155 feet long below the cutoff.

The tunnel was driven through various classes of material. The first portion on the New York side was built through sand, which was withdrawn through the tunnel. When the river silt was reached, the shield was closed with steel doors and it was forced bodily ahead, the silt being so plastic that it flowed around the advancing shield. The pressure involved was so great that it became practically impossible to guide the shields by varying the pressure on the jacks, and the keeping of it in alignment was done by opening the necessary doors in the face of the shield.

In conclusion it is gratifying to be able to state that the tunnel is unusually dry, this being due largely to the use of an alloy-steel bolt which is much smaller than would be required if an ordinary carbon steel bolt had been employed. The tunnel also is of unusual strength, as is shown by the fact that, in spite of its great diameter, there is less deformation in it than is found in some tunnels of smaller size.

INTERIOR OF NEW JERSEY CAISSON

The caisson, during sinking, encountered a mass of piles, cribbing, et cetera, apparently all a part of an old bulkhead



BOTTOM OF A SHAFT CAISSON

Above is seen roof of working chamber of river shaft caisson; below is a six-inch layer of concrete to seal the bottom

The Invention of Human Speech

Articulation and Phonation Have Been Combined to Form a Ready Means of Thought Transference

By SIR RICHARD PAGET, BART.
Fellow of the Physical Society of London, Fellow of the Institute of Physics (England)

HUMAN speech as it has come down to us at the present day is a combination of two separate "inventions" or arts. There is the art of phonation or humming which is produced by the passage of air between the vocal chords, just as the sound of a trumpet is primarily produced by the passage of air between the compressed lips of the trumpeter. In each of these cases the airstream is divided up into a rhythmical succession of puffs which produce in our ears the sensation of a musical sound. The other invention is that of articulation, that is, the method of altering the internal shape of the cavity or body of the instrument through which the humming sound is passed, namely by the movements of the human tongue, lips and throat. These two arts are essentially different and fulfill different purposes.

PHONATION—the humming sound produced by the vocal chords—is the language of our emotions. It is found in the lower animals, and was doubtless used by the primitive ancestors of man to express their emotional states—such as anger, challenge, fear, warning, pleasure, pain, love—long before speech itself was invented. Articulation, on the other hand, is the language of the mind. It is the method by which we convey our thoughts, as distinct from our emotional states.

Articulation can be used by itself, that is, without phonation, as when we blow air from our lungs through the cavities of our throat, mouth and nose without allowing our vocal chords to come together sufficiently to set up vibration. In this way the movements of articulation produce whispered speech. In the English language, we can make all the various speech sounds—vowels, diphthongs, and consonants—without the aid of the vocal chords.

When, instead of simply blowing air through the vocal cavities, we blow pulsating or vibrating air (due to vocal-chord action) and then make movements of articulation, we get the phenomenon of voiced speech. Voiced speech has many advantages over the whispered variety. It can be heard from 10 to 20 times as far, it carries an emotional as well as an intentional or mental message, and it has the quality of melody from which human song has been developed.

It is easy to see why, when once the methods of articulation, as a means of thought-transference, had been discovered, articulation itself was usually combined with phonation. It is not so obvious how the transference of thought by articulation came to be devised.

The probability is that articulation was developed from the earlier device—common also to other animals—of explaining ideas by bodily gesture. A dog who bars the passage to his foe shows his teeth, he greets his friend by jumping up and down, he leads his friend to the chase by running forward in the direction he has chosen and then comes back to encourage him to follow.

Underwood and Underwood

ARTIFICIAL VOICE PRODUCTION

Sir Richard Paget and his devices with which human speech can be imitated

So with man. He no doubt used his hands and face and body as a whole to indicate his wishes or his ideas. His "language" (at that time) was primarily a gesture language, comparable with the gesture language of the American Indians or of deaf-mutes, but combined with emotional cries, and calls for attention.

Then, as man became more and more an artist and craftsman, his hands became too much occupied and his gesture language became centered in his face and jaw, and his lips and tongue. Gestures which had previously been made with his hand, or with his hand and mouth together, became centered entirely in the mouth, and the human tongue took on the gestural functions of the human hand.

Let the reader try the experiment, before the looking-glass, of making a few simple gestures with his tongue. If he shakes his tongue, as his hand would shake a mat, and at the same time phonates with his vocal chords, the result is a "word," like "olly-olly" or "orry-orry." If he makes a digging gesture with his tongue, beginning with the tip of the tongue touching the roof of the mouth, then plunging it downwards behind the lower teeth, then flinging it upwards and slightly backwards towards the roof of the mouth, he will get a word like "tah-ree" or "tah-dee."

Dr. Whymant, who is an authority on early Chinese, Japanese and Polynesian language, tells me that "ore-ore" did mean "shake," and that "tadi" meant "dig," in some of these early languages.

Many of the Aryan root-words such as "da," meaning "give" (from which our word "data" is derived), "ap," meaning "seize" (from which "apt" is formed), "ku"—"swell out," (whence cave), "mar" or "mal"—grind" (mortar mill) "dhargh"—"make firm" (whence drag), seem to have been originated in the same way—namely by making a pantomimic gesture with the tongue, lips or jaw to indicate the action or quality intended to be conveyed.

EVERY such pantomimic gesture produces a corresponding change in the interior form of the vocal cavity, and thus produces a change in the character or intensity of the resultant sound. In recognizing speech by ear we are really (subconsciously) listening for evidence as to the movements and postures of the tongue and other organs of articulation and, having identified the movements which produced the speech sound we (again, subconsciously) decode these movements back again into thought.

It is in this way that man has learned the method of thought-transference by articulation. The question arises—how do the movements of articulation produce the sounds of speech? Figure 1 gives in diagrammatic form a section of a human head showing the vocal cavities. The vocal chords are a pair of lips (about one-half the size of the lips of our mouths) lying fore-and-aft across the top of the windpipe. Immediately above them are another pair of lips, those of the false vocal chords, which are much longer and thinner and

can be moved downwards so as to cover the vocal chords or upwards so as to make a bell mouth into which the orifice between the vocal chords opens out.

Still further up is the epiglottis. This is a movable flap at the back of the tongue which can be bent back and down, as in swallowing, so as to cover the false and true vocal chords, or partially back to constrict the passage at the back of the tongue. Or it can

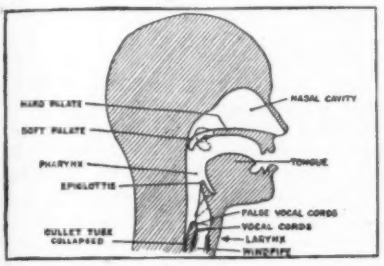


FIGURE 1

lie close up against the back of the tongue.*

The soft palate is the "valve" which closes the passage from the pharynx to the nasal cavity. It can be moved into a variety of positions (such as that shown in dotted lines) to open the passage to the nasal cavity or to co-operate with the tongue in making a complete or partial closure of the air passage from the lungs to the lips.

The tongue can make complete or partial closures in a variety of positions against the hard palate or the teeth, while the lips, besides making complete or partial closures, can also protrude more or less so as to make an additional cavity in front of the teeth.

Figures 2, 3, and 4 show the approximate positions of the organs which produce the sounds "a" as in "ah" or "calm," "i" (ee) as in "eet" and "ɔ" (aw) as in "more." It will be seen that at each fresh posture of the tongue, lips and epiglottis, the interior form of the "body of the instrument" through which the airstream passes is changed. Generally speaking, there are always two main cavities formed, one behind the hump of the tongue and one in front. Each of these cavities has its own musical note to which it "resonates."

The effect of the movements of articulation is therefore simply to vary the tuning of the cavities through which the airstream passes. When we make a complete closure, as in articulating a "p" or "t" or "k," all resonance suddenly ceases, but it begins again as suddenly when the closure is released. The only difference between a "p" "t" or "k" is that, as the closure is released, the tuning of the cavities alters in a *different* way in each case and we are thus able to identify *where* the closure was made by the way in which the resonances change. All these postures and gestures of articulation can be imitated in models, so as to produce recognizable speech sounds, without imitating at all closely the actual forms of the vocal cavities which produce them. It is only necessary to have the same number of cavities present and to tune them to the same pitch as that of the cavities of the mouth which produce the sound in question. The principle of tuning is substantially that of the "Helmholtz resonator," that is, the pitch produced depends on the relation between the volume of the cavity and the size and neck-length of its orifice. The bigger the volume—the lower the resonant pitch; the bigger the orifice—the higher the pitch. Increasing the neck-length of the orifice lowers the pitch.

FIGURE 5 shows in section a number of vowel-sounding models, made of plastic modeling clay and provided with "vocal chords" consisting of a rubber strip laid edgewise across the air passage so as to vibrate laterally when air was blown past it. Each model provides two resonating cavities connected together "in series." These models will produce recognizable vowel sounds. The consonants—which, as will be remembered, are produced by gestures of the organ of articulation—require moving parts of some kind to vary the start and stop and vary the resonances in the appropriate manner.

Figure 6 shows a model designed to articulate the consonants "m" or "n" with the vowel "i" (as in "it"). Closing and releasing the mouth of the model by hand articulates "mi," closing and releasing the "central orifice" between the tongue and the palate produces "ni." The two movements in succession articulate the name "Minny."

The consonants "p," "t" and "k" can be recognizably produced by employing a flexible rubber tube as the vocal cavity and varying its interior form by pinching the rubber from out-

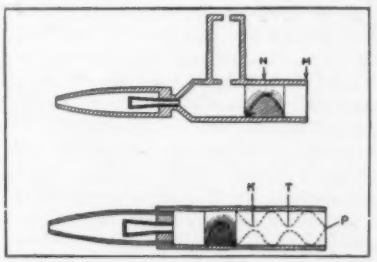
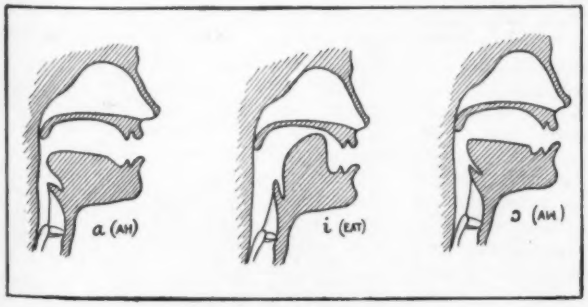


FIGURE 6

side. The associated vowel quality is given, as before, by giving the tube a waistline of the appropriate height and size. With such a resonator—shown in Figure 7—closure and release of the mouth of the tube gives "p," closure and release in the "t" and "k" positions give the corresponding consonant sounds.

Finally, many of the speech sounds can be produced by using the human hands as a vocal cavity, in which three fingers, held side-by-side, act as a movable tongue to divide the cavity into two resonators. In this device, which I have named the "cheirophone," the air, which may be supplied by bellows or by the performer's mouth, passes through an artificial larynx containing a reed which produces the "phonation," while the performer's fingers produce the articulation. It is thus possible to speak simple sentences such as "Oh Lilah, I love you"—"Hullo, London, are you there?" and so on. Some sounds, such as "k" and "t" are difficult to produce, owing to the difficulty of obtaining airtight closures. The human tongue is far from being an unruly member, but like the best of automobiles, it needs a good driver. Let us take a pride in driving it well!

* I am indebted to my friend, Professor G. O. Russel, of Ohio University, for much new information as to the action of the false vocal chords and the epiglottis in articulation.



FIGURES 2, 3 AND 4

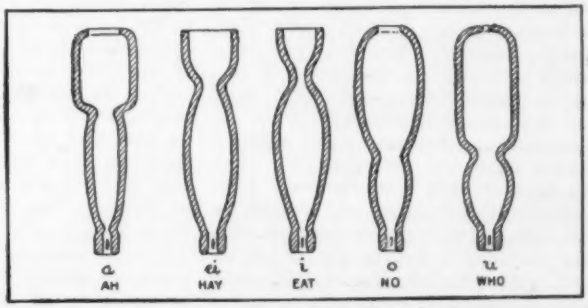


FIGURE 5

OUR POINT OF VIEW

NAVAL LIMITATION

IT is altogether reprehensible that the success of the naval limitation conference at Geneva should have been imperilled by the unfair, and indeed in many cases positively mendacious, propaganda that was carried on in the daily press before and during the meetings of that most important gathering. Unfortunately, questions of naval strength, involving, as they necessarily do, matters of the strategical situation of the various countries concerned, are not intelligible to the average layman. The various newspaper correspondents at Geneva were dependent for their so-called facts upon the naval officers of the various navies concerned. "Parity," that word which has been bandied about so freely, cannot, in the nature of things, be determined by the mere questions of total tonnage or total numbers of ships. The strategical situations of the United States, Great Britain and Japan are widely different, and it should have been the part of the naval men who have informed and guided the correspondents of the daily press, to keep before the people of the world these wide differences, and to show why Japan calls for many submarines, Great Britain for many cruisers, and the United States for absolute parity in every class of ships.

The United States realizes the great debt of the Allies to the British Navy, which for four years held the German fleet fast in its grip. Had the enemy broken through to the high seas, not a single American regiment would have sailed for France, nor could the colonials have gathered from the four corners of the earth. The desire of the British for sufficient small cruisers to safeguard her sea routes is reasonable.

However, at the present writing, it looks as though the conference was going to weather this storm of unfair and misleading newspaper propaganda, and that the three leading navies concerned will get together on a basis which will recognize the strategic situation and the consequent necessities of each nation, and at the same time maintain the hard-and-fast 5-5-3 ratio determined upon at the earlier Washington conference, when battleships and airplanes only were covered.

Suspicion, distrust and jealousy should never be permitted to enter the doors of such a conference. Misrepresentation, above all, should be banished. The surest measure of success at Geneva lies in the belief by each nation in the honor and good faith of the other two nations, and a determination that good sportsmanship shall prevail throughout the whole deliberations.

SAVE THE WATER

IF someone should tell you, casually, that New York City wastes 280,000,000 gallons of water per day, you would probably receive the statement with a smile of incredulity. Nevertheless, we have the authority of the Water Works Research Bureau of this city for the statement that this is the amount of water now expended to no useful purpose, and that, expressed in terms of dollars and cents, this means that New York City is throwing 20,000 dollars daily into its sewers.

In bringing drinking water from reservoirs which, as in the case of New York City, are approximately 100 miles distant, and then distributing it through miles of water mains, there will inevitably be certain losses by leakage. These, however, are insignificant, compared to the wastage which occurs through the careless and extravagant use of water, which always occurs with an unmetered supply.

An unmetered supply is an encouragement to waste, not, of course, on the part of everyone, but as regards the great majority. "Easy come, easy go" is never so true as in the use of water. Why call in a plumber to fix a leaking tap or faucet when the water so lost passes harmlessly into the drainage pipe and causes the householder not the least inconvenience? One does not have to look very far to note that, in the round of daily life, the "grown-up" easily reverts to the carelessness and extravagance of childhood when the conditions are such that "you may take all you wish."

But we must remember that somebody has to pay the 20,000 dollars a day which is thrown by the careless user of water into the city's sewers. It has to be made good by building, every few years, additional reservoirs to keep pace with the demand. Thus New York will pay 350,000,000 dollars to develop the Delaware River watershed for an additional supply of 600,000,000 gallons, and this means a proportional increase of taxation. It means, furthermore, that the conservative users of water have to pay out of their pockets for the extravagance of those who waste wilfully.

What applies to New York City is true of all municipalities that fail to install meters. It has been estimated that by metering it would be possible to cut the water use of Chicago nearly in half, without subjecting the citizens to any inconvenient limitation of their daily supply. New York's average per capita daily use is 139 gallons with 26 percent of the supply metered; Chicago, unmetered, uses 296 gallons per capita; but Los Angeles, 99 percent metered, uses only 119 gallons per capita. The moral is obvious.

Lawrance

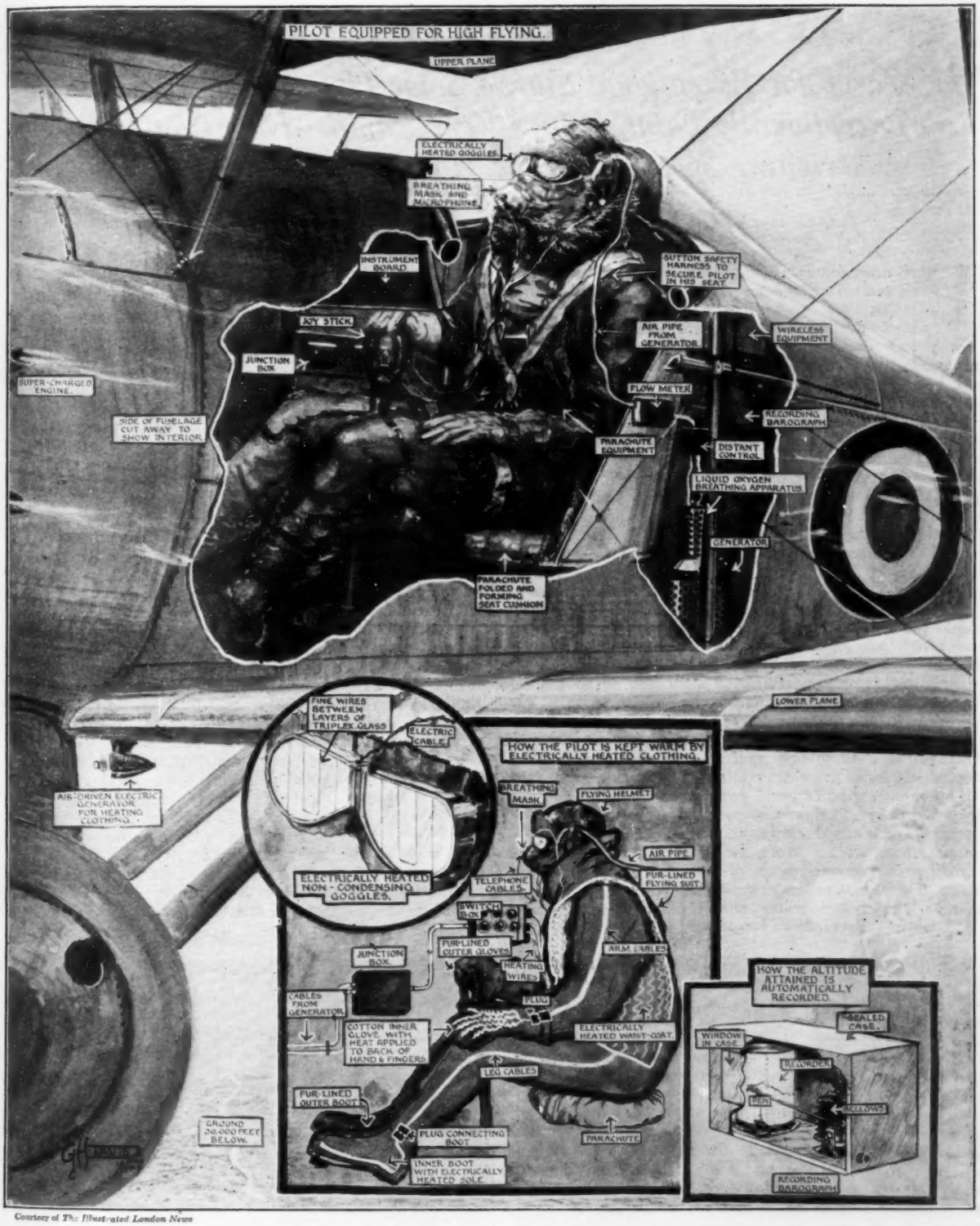
WITH the successful flight from San Francisco to the Hawaiian Islands of Smith and Bronte, one more chapter has been written in the amazing series of trans-ocean flights that have marked the past two months. Two civilians, in a small single-engined monoplane, flew in practically continuous foggy weather, and apparently without any sight of the ocean below, yet nevertheless they hit their objective, a most remarkable feat of navigation. Again it was the air-cooled engine designed by Charles L. Lawrance (See page 148, et seq., August, 1927, SCIENTIFIC AMERICAN) that carried the plane through. The word "heroic" can scarcely be applied to a man who sits with pad and pencil over a drafting board; but we think that to no one is greater credit due than to Lawrance, whose air-cooled engines have made these record-making flights possible.

WANDERING OIL WELLS

A RATHER dramatic proof of the reliability of the oil-well surveying machine, which we described in the article in our July issue entitled "The Wanderings of an Oil Well," has been afforded by two wells which are being drilled in the southwestern oil fields. Both wells are in the famous Spindletop field. One, known as Oakwood Number 12, had been driven down 2255 feet; the other, McLean Number 14, was down about 3500 feet, when "the two drill-stems ground into each other."

When the wells were started they were 84 feet apart, and it is estimated that the angle between the two holes at the point of intersection is two degrees and ten minutes. It was with great difficulty that the interlocked stems were pulled apart.

Oil men relate that only one previous case of this kind is recorded, that occurring in California, when two wells that were 300 feet apart at the surface intersected during the later drilling. The vertical and plan views in our July issue showed that the deviation from vertical was 517 feet at the 6000-foot level, and that in plan the well wanders around three sides of a rectangle.



Courtesy of *The Illustrated London News*

Flyer Equipped For High-Altitude Work

At the recent display of the Royal Air Force in England, much attention was focused on the events in which fast-climbing planes attempted to break existing altitude records. In order to do this, the planes and their pilots had to be specially equipped. The engine will not function properly in rarefied atmosphere, so it is necessary that it be equipped with a supercharger. Thus sea-level conditions can be simulated at extreme altitudes. The pilot must be kept warm in the low temperatures of the upper regions and this is accomplished by means of electrically heated clothing. To compensate for the lack of oxygen in the air, a generator is supplied for producing that life-sustaining gas. The details of the equipment are given in the illustration reproduced above.

Odd Stars

The Search for Exceptional Stars---Some Unusually Bright, Some Exceptionally Faint, Others Very Rapid---Forms an Intriguing Specialty for the Modern Astrophysicist

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

THE astronomer is always seeking new worlds to conquer. No matter how far he has been able to push his advance, there is always something just beyond which tempts him to renewed efforts. Indeed, he is as insatiable as the traditional Yankee farmer, who, being reproached by the parson for undue love of this world's goods, and in particular for the purchase of land, replied: "I don't need so much. I only want to buy up all the land that adjoins mine." As he was not a resident of an island, this policy might lead him rather far; and we star-gazers own that the tale describes us.

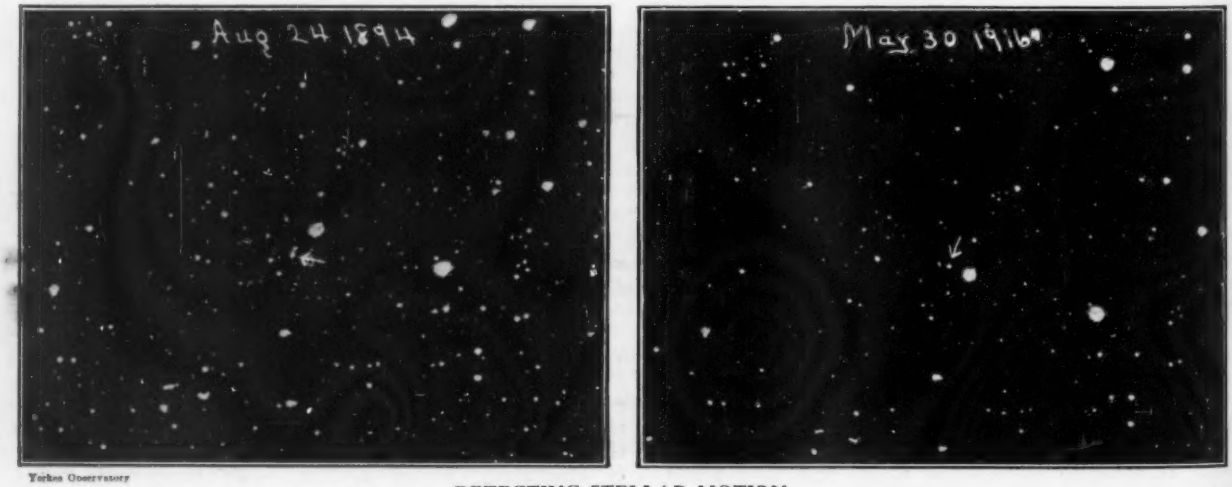
There is always a particular interest in the exceptional objects which lie outside the general run—for example, stars which are unusually bright, or especially faint. One is not speaking, of course, of their appearance to our eyes, which is so greatly affected by differences in the stars' distance, but of their real brightness. The apparent brightness is a very easy matter to measure—at least if we are contented with an accuracy of 10 or 15 percent; but to find the real brightness we must determine the star's distance, and this demands more work. We have now, however, so many good ways of measuring, or at least estimating, stellar distances, that this obstacle, once almost insurmountable, is no longer the barrier that it used to be. But, when we seek after stars which lie outside the general run, we have new troubles of our own. How can we pick them out from the great mass of others?

Consider first the stars of great luminosity, which, as we say technically, are very bright in absolute magnitude, and exceed the sun's output of light by a thousand-fold or more. There is no trouble in seeing such stars—even if they are far in the depths of space they will be fairly conspicuous. A star like the sun in brightness will be visible to the naked eye only if its distance from us does not exceed 60 light-years. This is fairly near by, as stellar distances go, and the great majority of the stars which are visible without optical aid are farther off, and of course brighter. But a star 10,000 times as bright as the sun can be seen without a telescope, if it is anywhere within 6,000 light-years; and with so vast a region of space in which to search we might expect to find a good many. They will look, however, just like the fainter stars which lie nearer us, and our problem is to pick them out.

WE have now two good ways of doing this. First, the spectra of these very bright stars show distinctive peculiarities—some of the lines being unusually strong, and others weak, in comparison with stars of about the same temperature but lower luminosity. Secondly, these stars, as spectroscopic observation shows, are moving in space at about the same rate as the sun—indeed, a little more slowly. Hence at these great distances their apparent motions across the sky will be exceedingly small. These "proper motions" have been observed with great care for all the brighter stars, and we have therefore another important guide. But it is not an infallible guide, for, if a star happens to be moving straight towards the sun or away from it, it will appear to be standing practically still in the heavens, no matter how near it may be or how rapid its real motion.

Study of the spectrum enables us to pick out these cases and reject them. We are left with the problem of determining the actual distances of the stars which we have already identified as exceptionally bright, and this is hard, because the parallaxes are very small. But in many cases, notably among the members of star-clusters and star-clouds, we can solve the problem, and our present knowledge of the very luminous stars is fairly satisfactory.

The most luminous known star is a variable, S Doradus, which is in the Smaller Magellanic Cloud at a distance of 100,000 light-years, and gives off



Yerkes Observatory

DETECTING STELLAR MOTION

Barnard's star in Ophinchus, having greatest known proper motion. Double plate showing marked change in position in 22 years

when at its brightest half a million times as much light as the sun does. Such tremendous stars are very rare. If we restrict ourselves to the more moderate limit of 10,000 times the sun's light we shall find, according to Kapteyn, only one star of this sort among 200,000 stars as bright as the sun, provided that we make a census of all the stars in some vast but circumscribed region of space.

When we pick those visible to the naked eye we include all stars of the brighter sort which lie within a region of space a million times greater in volume than for the fainter ones, and so our minority is likely to be turned into a majority although the intermediate stars, 100 times as bright as the sun, outnumber both the other kinds in our new count.

For the very faint stars, which give off less than a thousandth part of the sun's light, the problem is very different. Such stars are really very abundant; we believe now that there are more of them in any given million cubic light-years of space than of all the brighter ones taken together. But the fact that our observations are controlled by the apparent brightness of the stars now works heavily against us. A star a thousand times fainter than the sun, to be visible to the naked eye, would have to be less than two light-years distant, and no known star is so near. If we change our limit of apparent brightness—make it, for example, a thousand times fainter—we shall now include all the faint stars of the kind we are discussing which are nearer than 60 light-years, and there should be some dozens of these—perhaps a few hundred. But in lowering our limit of apparent magnitude we shall at the same time have let into our lists millions—literally millions of stars which are really brighter and farther off, but look about the same.

OUR problem is now that of the needle in the haystack, and would be hopeless were it not for other aids. For such faint stars, wholesale spectroscopic observation by the million is impracticable; but the proper motions remain. These faint stars have, on the average, rapid real motion, and once they are so near us their apparent proper motions will usually be very large. Our problem is then to find out, among a million or so of stars, those which move fastest in the sky; and this can be done almost by machinery. We have only to photograph the heavens with a wide-angle astronomical camera, to repeat our plates a few years later, and to compare the two. We shall need a "blink-microscope," that ingenious apparatus which can be focused on two different plates of the same field, so that by shifting a little lever we see alternately one and the other as we look through the eye piece. By proper adjustment, we can bring all the stars which have not moved perceptibly to just the same position in the two cases—and then any star which has moved will appear to jump as the lever is shifted back and forth. This makes it very easy to pick out the one moving object among ten thousand—and incidentally it leads to the discovery of swarms of variable stars, asteroids, and so on. One can make a blink microscope, crude but good enough to illustrate the principle involved. On a paper place two groups of heavy dots, identical in pattern except that one dot will have a new position in one group. Hold a card on edge separating the groups, bring the eyes close to the card and open and close either eye alternately and rapidly. The one dot betrays itself by dancing.

WHEN once we have picked out the stars of large proper motion, the rest of our job is straightforward. We must photograph them with large telescopes, when the earth is in opposite parts of its orbit, and find the parallax by the familiar range-finding methods. These stars are near us, and have large parallaxes which can be measured with satisfactory percentage accuracy. Some of them, perhaps most, will turn out to be objects at moderate distances—20 to 50 light-years; and with very rapid real motions in space. But there will be others which owe their rapid apparent motions not to great speed, but to unusual proximity; and here at last we shall reach our objective.

The nearest known star was discovered in this way—Innes's faint companion to Alpha Centauri, which is moving in space along with it, but appears to be a little nearer to us (four and one-quarter light-years); and so was the second, Barnard's star, which is only six light-years away.

Another star of the same sort has just been added to our lists. It is a 13th-magnitude star in Virgo, and is known as Wolf 359, since it bears this number in the list of proper-motion stars discovered photographically by Professor Max Wolf at Heidelberg. The photographs show that it has the remarkable proper motion of 4".84 per year—surpassed by only six stars known at the time of its discovery. So faint a star can be observed for parallax only with a very large telescope, but Van Maanen, with the 100-inch reflector at Mt. Wilson, has obtained an excellent series of plates, and has just announced his result, a parallax of O".404+-O" .009, making the star's distance eight light-years—a little less than that of Sirius. Only two other known stellar systems, that of Alpha Centauri, and Barnard's star, are nearer. The real motion of this star (at right angles to our line of sight) is not remarkable, being 57 kilometers a second. The radial velocity is shown by the spectrogram to be approximately 90 kilometers per second, that is, the star is approaching us at this rate.

A simple calculation shows that about 70,000 years hence it will be as near as Alpha Centauri is now, and will have a proper motion of 17" per year. Even so it will be fainter than the 12th magnitude. Its absolute magnitude, compiled by Professor Kapteyn's formula, is 16.5, which in plain English means that it gives out only one fifty-thousandth part of the sun's light. This is much less than for any star which was previously known—the next in the list, Innes's star, being four times brighter.

The spectrum of so faint an object is naturally of great interest, and in spite of the extreme feebleness of its light, Humason has succeeded in observing it with the great reflector and a spectroscope designed especially for very faint stars. The photographed spectrum is only about a quarter of an inch long, but shows many details, sufficient to place it in the spectral class M 6, which corresponds to almost the lowest temperature which is found in stellar atmosphere. The hydrogen lines are bright, as is the case in some other very faint stars—no one yet knows why. As might be expected from this spectrum, the star is very red, and is only about one-sixth as bright photographically as to the eye.

WHAT its real size may be is a little hard to estimate, for we have only the scantest data to guide us in the case of such low temperature, but these data indicate that the star is probably of about one tenth of the sun's diameter—no bigger than Jupiter, and perhaps as small as Saturn. Its mass may be roughly estimated, by means of Eddington's relation between mass and brightness, as about one tenth of the sun's, which would make the density something like a 100 times that of the sun, or very likely more. It looks, therefore, as if this star was far advanced in the scale of density, although still falling very much short of the enormous density of white dwarf stars like the companion of Sirius.

There are still as good fish in the sea as were ever caught. Professor S. E. Ross of the Yerkes Observatory, who is engaged in a systematic search for proper-motions with the aid of Professor Barnard's splendid collection of plates, has just announced the discovery of a thirteenth magnitude star in Cancer with the very large proper motion of 5" .40 per annum. In a couple of years, when the parallax observations are made, it may turn out that this star is even a nearer neighbor.

Specimens From the Telepathic Mine

There Is a Mine of Interesting Evidence Tending To Establish the Genuineness Of Thought Transference

By WALTER FRANKLIN PRINCE, Ph.D.
Research Officer, Boston Society for Psychic Research

IN a short article I can only casually exhibit a few "specimens," and assure readers that they represent many careful tests; there is not space to describe the details of even one essay.

Charles Richet, Professor of Physiology at the University of Paris, tells us that on July 2, 1888, "Leonie" spent all day in his laboratory, and when in a state of hypnosis at 8 P.M. was asked by him (referring to a man whom she had seen several times but not recently): "'What has happened to M. Langlois?' 'He has burnt himself,' Leonie replied. 'Good,' I said, 'and where has he burnt himself?' 'On the left hand. It is not fire. I don't know its name. Why does he not take care when he pours it out?' 'Of what color,' I asked, 'is the stuff which he pours out?' 'It is not red, it is brown; he has hurt himself very much—the skin puffed up directly.'"

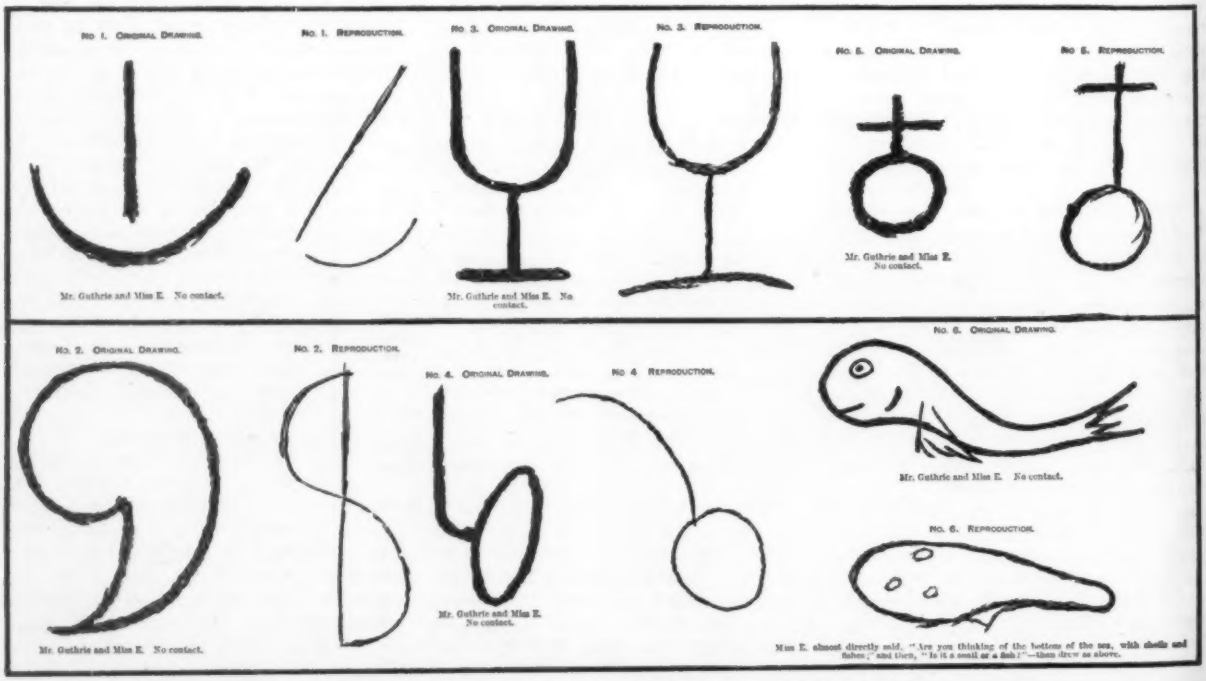
Every detail of this was exactly true; the accident happened four hours before the utterance, and Professor Richet declares that neither had he mentioned to anyone the burn received by M. Langlois on his left hand when he too hastily poured bromine from a bottle, with consequent blistering, nor could Leonie possibly have heard of it from anyone else.

If this incident stood alone, no authority on earth could make me believe that there had not been a mistake, but there are a multitude of such incidents on record too well vouched for to be lightly put aside. Certain of these incidents within the circle of my own observation have already been told in print.

DURING an indefinite period in the past, persons have thought that they had evidence in their own experience for mental communication, but proper recording of supposed instances was practically never done, until within a recent period. The (English) Society for Psychical Research did much pioneer experimentation in telepathy, and still furnishes occasional studies.

Mr. Malcolm Guthrie, J.P., seems to have been one of the earliest and most indefatigable hunters for good subjects and experimenters for telepathy that the Society for Psychical Research produced. Apparently, also, he was a careful experimenter, as the descriptions of his technique show. In the Society for Psychical Research *Proceedings* of 1883 may be found a summary of about 150 experiments for the transfer of drawings (that is, the "agent" makes a drawing out of sight of the "percipient," and the latter draws the impression she gets), the percipient being part of the time Miss R. and part of the time Miss E., the agents varying. The drawings which are reproduced in this article represent the complete and consecutive series of a single sitting. No one was in the room but the agent and the percipient. Probably there was no other quite so successful consecutive a set of six in the whole series as this, but there were many remarkable successes, witnessed by various persons.

In 1885, Mr. Guthrie reported further experiments, in which two shop girls, named Relph and Redmond,


No. 1. Original Drawing.
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No. 5. Original Drawing.
No. 5. Reproduction.
Mr. Guthrie and Miss E. No contact.
Mr. Guthrie and Miss E. No contact.
Mr. Guthrie and Miss E. No contact.
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Mr. Guthrie and Miss E. No contact.
Mr. Guthrie and Miss E. No contact.
Mr. Guthrie and Miss E. No contact.
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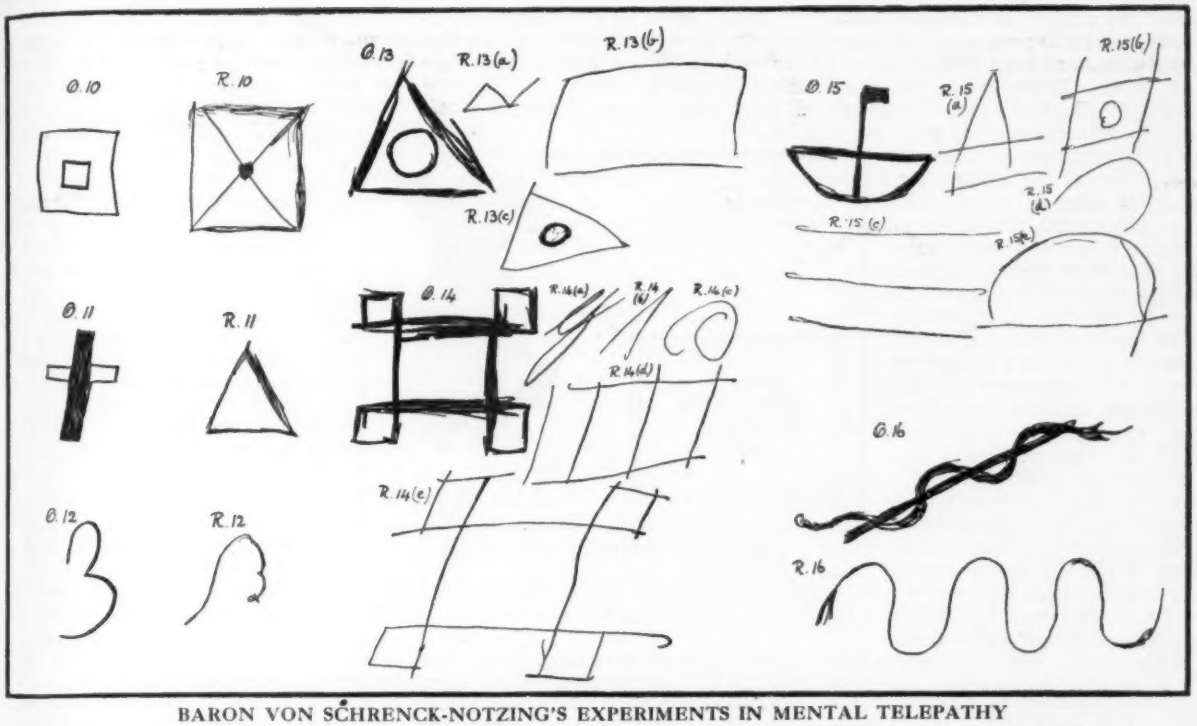
Miss E. almost directly said, "Are you thinking of the bottom of the sea, with shells and fishes," and then, "Is it a snail or a fish?"—then drew as above.

SIX TESTS IN THOUGHT TRANSFERENCE, MADE IN ENGLAND

The originals were drawn in another room from that in which the subject was placed. To catch the thought involved in the drawings usually took a minute or two. These tests are described in the Proceedings *of the Society for Psychical Research, Volume II, pages 24 to 42, where a considerably larger number of tests of the same general nature are also described in detail*



BARON VON SCHRENCK-NOTZING'S EXPERIMENTS IN MENTAL TELEPATHY

In each case there is an original sketch (marked O) made by those who conducted the tests. Near each original is the sketch or sketches drawn by the recipients. Several efforts were sometimes necessary to get the picture, and in some cases there was failure

were the subjects. There were varied conditions, and varieties of experiments. In some sets the tests were solely written; sometimes agent and percipient were in physical contact and sometimes not. Several persons in turn acted as agent.

The following were experiments without contact, all consecutive: Miss Relph, percipient. Others present, besides Miss Redmond, were Dr. Hicks, president of the Microscopical Society of Liverpool; Mr. Birchall, Honorary Secretary of the Literary and Philosophical Society of Liverpool, Mr. Johnson, and Mr. Guthrie, J.P. Subject blindfolded, and with back to company.

1. Persons present pricked palm of left hands with pins. Answer: "Is it a tingling pain here?" (touching palm of left hand.)
2. All pricked back of necks with pins. Answer: "Is it a pricking in the neck?" (touching back of neck.)
3. Mr. G. held gold watch against his coat. Answer: "Are you looking at something yellow? Is it round; something like an orange? But it is not an orange."
4. Mr. G. held a pair of bright steel pincers, closed. Answer: "Is it something bright? I saw a flash of bright light, but no shape."
5. Object, a piece of bluish-green silk, trapezoid shape. Answer: "Is it blue? A greenish blue? Shape not well defined."

On another date, Messrs. Johnson and Guthrie being present with the two young women, experiments in thinking of pictures were tried, the subject being written, not spoken. The first, "Too Late," one lately on exhibition with many others, Miss Relph visualized and named; the second test was da Vinci's "Last Supper." Guthrie mentally pictured Jesus as holding a goblet, while Judas dipped something into it. Miss R. said: "Is it the last days of somebody? Somehow there seems to be a dying man, and a lot of people in the room. A bed with a dying man, and some one holding a paper or something to him, or else he is holding it." Even this technical failure is curiously like the truth. Then the picture "Dante Meeting Beatrice, et cetera" was chosen, but Miss R. got no impression. The following one, "The Flight into Egypt" was correctly named in about four minutes. "Mary Anderson" was a failure, but "Ellen Terry as Portia" succeeded. Just two more experiments of the kind were made; in one there was no impression, and the subject of the other was wrongly given.

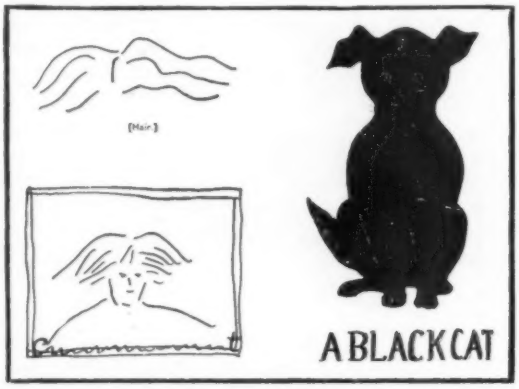
In 1889 Professor and Mrs. Henry Sidgwick superintended experiments for telepathy on many different days, the subjects being in a hypnotic state and the hypnotizer, G. A. Smith, acting as agent. Most of the experiments were for the transference of numbers, the agent drawing from a bag one of 81 counters numbered 10 to 90 and gazing at it out of view of the subject. A number of hypnotized persons had no success, but four seemed to have telepathic power in that state. A Miss B. succeeded amazingly. Out of the following numbers drawn from the bag, 16, 67, 18, 37, 71, 66, 62, 50, 84, 15, 88, 15, she got all but three correctly and without any fumbling in the process, in all other three cases getting one of the figures correctly. Another

Does Mental Telepathy Ever Take Place?

From the first it must be admitted that no absolutely positive proof of thought transference has ever been demonstrated. There have been innumerable cases that bear strong earmarks of the genuine—indeed, most of us occasionally experience them—yet it is extremely difficult to prove them in a thoroughly scientific manner. That is, the criteria of a truly scientific proof are distinctly higher than those most of us are usually willing to accept in our daily lives as establishing truth. In psychical research, seeing is not necessarily believing. The true, disinterested, scientific psychical researcher doubts everything and is vastly more rigid in his demands than the casual amateur. Such a researcher is Dr. Prince, the author of the accompanying article. —*The Editor.*

hypnotized subject at times had little success, but twice accomplished almost as remarkable a result as Miss B.

In 1890, Baron von Schrenck-Notzing, M.D., had a series of experiments with a number of subjects, which he summarizes in *Proceedings* of the Society for Psychical Research, Part 18. From the description of precautions taken, one would suppose that there was no chance for deception. The experiments were in the way of drawings which are reproduced here. Here the originals are marked O and the responses of the percipients marked R—where more than one attempt was made, they are marked R(a), R(b), and so forth, in experiments 10 to 14 inclusive, and in experiment 16. Despite the flat failure of 11, and the partial failure of 15, the set of seven experiments presents correspondences certainly vastly beyond the expectation of chance.



TWO MORE INTERESTING TESTS

The experimenter gazed at the peculiar dog-eared cat made of velvet. The recipient made the possibly analogous sketch on the left, and got the letters "c-t"

Miss Verrall, now Mrs. Salter and editor of the Society for Psychical Research *Journal*, in 1915 reported experiments with Miss K. Tipping, one of which is of curious interest. She gazed steadily at a black cat made of velvet, with the title beneath it, "A Black Cat." Miss Tipping visualized the face of a man, and made a rude drawing, which, together with the figure of the cat, is reproduced on this page. The man's hair spreads out very oddly on both sides of his head, much as the cat's ears oddly stand out. But, moreover, she wrote under the drawing "c—t", the first and last letters of the word cat.

DR. GARDNER MURPHY

Dr. Murphy of Columbia University has made many experiments on telepathy

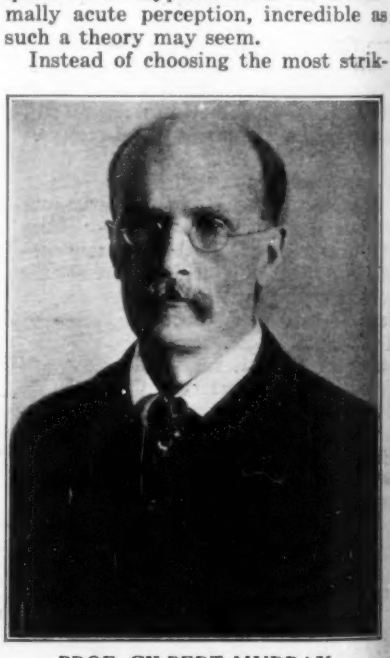
Two reports of the apparently telepathic work of Professor Gilbert Murray have been published in the *Proceedings* of the Society for Psychical Research (London). The conditions, briefly, were these: Prof. Murray goes into another room "out of earshot," and someone in the company selects a test and tells it to the others in order that all may fix their minds upon it; Professor Murray is summoned and gives his impressions. Some of the tests were quite complex, such as the invention of an anecdote with names of particular persons, places and acts included, so that it would not be supposed that there was one chance in thousands of a correct guess, even though the percipient was in physical contact with the selected agent. How could muscle-reading give knowledge that the agent was thinking of the game Badminton being played in Bogota, one of the players being a Mr. S——, and one person present Lord Murray—the whole incident being an invented one?

THERE were 505 experiments before 1916, which the accomplished Miss Verrall analyzed. She found the following percentages (omitting 68 cases where no impression was received): successes, 38.2; partial successes, 32.3; failures, 29.5.

Generally, Mrs. Toynbee, a daughter of Professor Murray, acted as agent, or ostensible sender of the mental messages, and she has always produced the largest percentage of correct results, a fact in accordance with the principle that a peculiar *rapport* exists between certain pairs of people. It is difficult to suppose that a man of such distinction as Professor Murray, one who appears, moreover, to be considerably embarrassed at his notoriety for "psychic" power, should lend himself to deceit and should actually be in collusion with his daughter, yet this has been suggested, and it is well that another series of experiments has been published in which many persons acted as agents, even though the average of their success was not so great. This series numbered 236 experiments and the learned and conservative Mrs. Henry Sidgwick, who drew up the report, estimates the percentages as follows: successes, 36; partial successes, 23.3; failures, 40.7.

Altogether six members of Professor Murray's family acted as agents in this second series in 167 of the tests, while 30 other persons acted in the remaining 69 experiments, and the experiments were held in several different houses. It will hardly be believed that 36 persons, even though most of them were acquaintances, were in collusion to deceive each other and the world. And it does seem strange, if such persons and so many should not have known how important it was to speak so that no sound could reach the room where the percipient waited. I do however, emphatically think that there should be a series of tests arranged in writing only, so that there can be no question of hyperesthesia or abnormally acute perception, incredible as such a theory may seem.

Instead of choosing the most striking successes, I will give one made in September, 1916, wherein Mr. Millor acted as agent. It will be understood that the language of the test was complete before the response began, and that it is only for economy of space that I have broken up the substance of Murray's response and interpolated its parts within parentheses after the relevant parts of the pre-



PROF. GILBERT MURRAY

One of the world's best telepathists, he is a famous Greek scholar at Oxford

viously arranged form of words constituting the test. In parts of the experiment, Murray said nothing relevant to the part of the test immediately preceding.

Mr. Millor acted as agent and independently chose his tests five times, each time selecting some public meeting which had occurred, but not giving any previous notice that the subjects would all be of this or any class.

> 62. "I'm thinking of myself addressing a strike meeting." ("This is you yourself waving your arms [the fact that Mr. Millor was accustomed to wave his arms when speaking may have been known to Murray] and making a speech, and I suppose it is addressing a strike meeting") "outside Baliol [Oxford] at the Martyr's Memorial." ("I guess *outside* the mill at Chipping Norton.")

IN Paris, M. Warcollier has been doing notable and significant work in the way of telepathic experimentation for some years.

Dr. Gardner Murphy of Columbia University has spent much time experimenting for telepathy, and most of his subjects have yielded no evidential results, but it is quite otherwise with several of them. A particular experiment, conducted by him and Professors Gault and English illustrates the same fact, that good subjects are rare. The three gave notice to radio audiences that they were concentrating on something of a class, as a figure between one and 1000, a pain at some point on the hands or arms, et cetera. Out of 2500 reports sent in, only two showed results presenting any problem, but one of these presented a mighty one, for it showed so many successes and to such a degree that it is conservative to say that the chance of getting them in combination was not one in a hundred million.

The latest American experimental work has just been published by the Boston Society for Psychic Research and has attracted considerable attention from men of scientific bent. I quote from Dr. Murphy's description of the methods and the results.

"My successor at Harvard, Dr. G. H. Estabrooks, has improved on my methods in several striking respects. First, he has chosen his subjects in a radically different manner. Instead of selecting only a few, he has rejected only those who could not or would not cooperate, has taken graduate and undergraduate students by the dozens, and many other individuals. He has found methods of winning the confidence of his subject and of interesting him in his task. The simple expedient of promising an exhibition of card tricks proved to be successful bait with a large number of undergraduate students who were taken just as they came.

"In view of the fact that his work is soon to be published, I can refer to his work only in a very general way. He made use of two rooms in the Harvard laboratory which are separated by a heavy double door. An automatic timing apparatus gives a signal upon which he cuts a pack of cards and concentrates intensely upon the card chosen. The same instrument causes the signal to be given in the other room in which sits the receiver. The latter writes down instantly and without allowing himself to "think," the name or number, and the suit of a card.

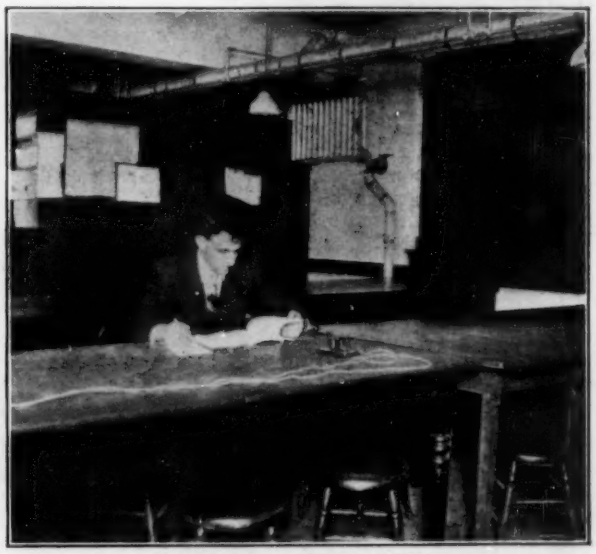
"The results, which will soon be available for you in tabular form, show not only that great statistical difficulties would occur in applying the usual explanation in terms of chance, but that the results are extraordinarily consistent. The best results are in the first five experiments with a given subject, the next best are in the next five, and at about the fifteenth experiment the results drop to what we should expect from chance. Statistical measure of chance is applied to color, suit and number. Consistently, the result from colors, that is the choice of red or black, is enormously better than the result from the suit or from the designation of the individual cards."

DR. ESTABROOKS be it understood, is very modest and tentative in his conclusions, and is still pursuing his experiments, which tend to show that, while marked telepathic power belongs only to the few, there is a trace of it in most people, which may be rendered perceptible by a mass of experiments properly conducted.

Laboratory experimenters are racking their brains to devise methods which will be proof against suspicion that the agent does not give even unconscious signs which the percipient cannot subconsciously interpret by even hyperesthetic (that is, abnormally acute) exercise of a bodily sense. With some subjects and by some experimenters, tests have been so complex and conditions apparently so strict that a "normal" solution seems to require that the agent unconsciously whispered words through his nose and the percipient hyperesthetically heard them, his hyperesthesia taking the peculiar form of unawareness that he heard anything at all.

THE EXPERIMENTS AT HARVARD

The sending end of the experiment described in the article; the receiving end is depicted in the illustration at the right



RECEIVING THE THOUGHT

In a separate room the receiver sits and at once writes down the impression when the signal is given by an electric device

MOON'S RUGGED EDGE OF CONTOUR SUN
BAILEY'S BEADS AS SEEN WITH THE NAKED EYE
BAILEY'S BEADS (HIGHLY MAGNIFIED) ARE CAUSED BY SUNLIGHT PIERCING THE LUNAR VALLEYS
SUN PARTIALLY ECLIPSED
IMAGES OF THE ECLIPSE PROJECTED UPON THE GROUND. THE INTERSTICES BETWEEN THE LEAVES ACT AS A SORT OF PINHOLE CAMERA

Courtesy of *The Illustrated London News*

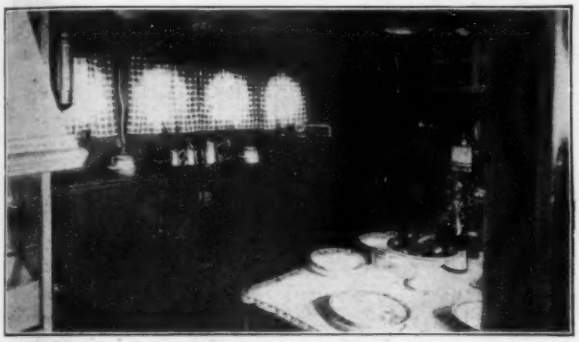
The June 29th Solar Eclipse In England

Two interesting phases of solar eclipses are graphically illustrated in the artist's drawing reproduced above. The first is that of Bailey's Beads, made possible by light passing through the valleys between the lunar mountains. Irradiation gives the naked-eye effect shown. The second is a photographic phenomenon wherein multiple images of the partially eclipsed sun are projected on the ground by the "pin-hole" camera effect mentioned.

All photographs by Underwood and Underwood

EQUIPPED WITH A RADIO SET

This is the trim bedroom of Monsieur Louvet's home on wheels, its seven windows resembling the portholes of a ship

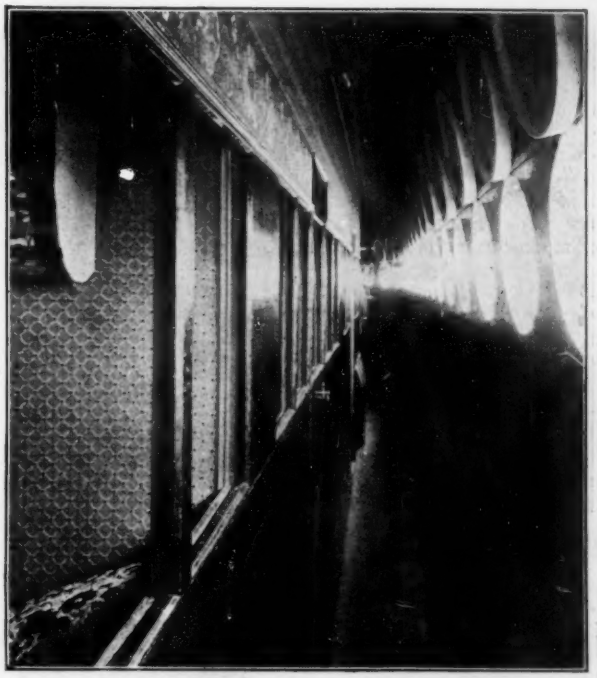


THE DINING ROOM AND GALLEY

In the background is a portable phonograph, also a portable typewriter. Everything is shipshape and nothing is crowded

THERE IS EVEN A BATHTUB

The tub fits the inside contours of the body of the caravan and there is running water, cold and hot (from the radiator)



LOOKING DOWN THE CORRIDOR

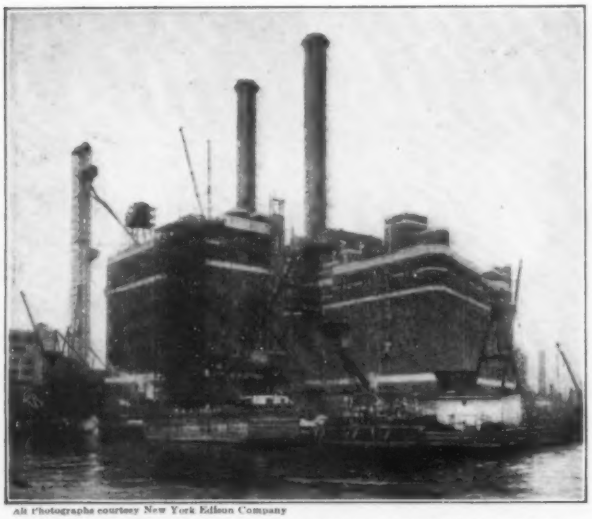
As in a French railroad coach, the long corridor runs along one side of the caravan, and the various rooms open off from it

THE CARAVAN AND ITS BUILDER

REAR VIEW: *The house is 36 feet long and was constructed—furniture, accessories and all—by the owner, within one year*

A Frenchman's Motor Caravan, a Home on Wheels

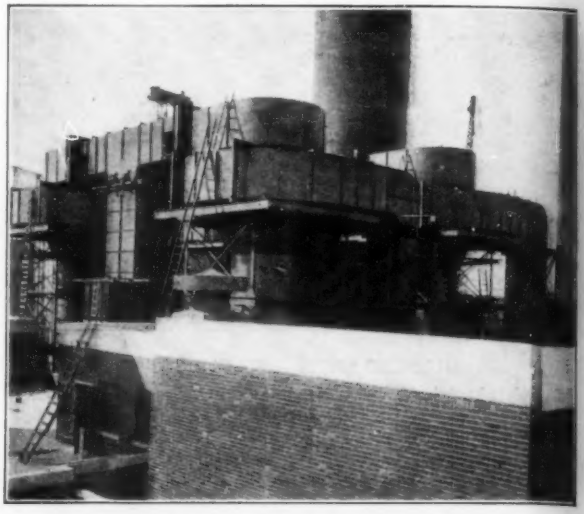
Monsieur Louvet, resident of Nice in southern France, decided recently to "see France first," and to see it with all the comforts of home. No sooner said, than he proceeded to construct a four-room house on wheels, and the reader of this issue of the SCIENTIFIC AMERICAN may therefore think of Monsieur Louvet at this very moment driving leisurely over the superlative highways and byways of his native France, or stopping to rest at some chosen spot. What a care-free life! No camp to make, for the camp is always with one and all made up. No baggage to worry about, for everything is carried aboard the caravan. Next year Monsieur Louvet plans to do the same thing in America, where he will, however, find things a little different. Although motor camping in this country has almost become a profession, there are relatively few large motor caravans of the kind he is using. In some sections where the roads are comparable in quality with those of France, there is a bit too much traffic for comfort, while in other parts of the country that might appeal most strongly to the motor camper, a 5000-pound vehicle may prove too heavy for extrication from the many mudholes. We advise Monsieur Louvet to replace his small tires with double-tread "balloons." And even then he may wish at times for caterpillar traction belts.



All Photographs courtesy New York Edison Company

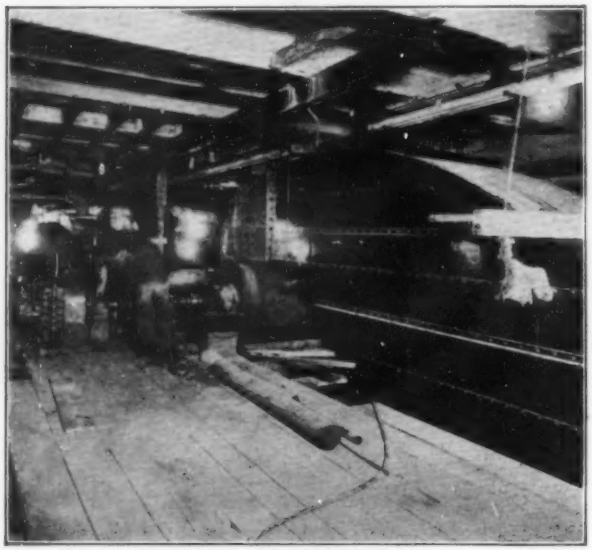
NEW YORK'S GREATEST GENERATING STATION

When completed this station will be nearly eleven hundred feet long and will have a capacity of one million kilowatts



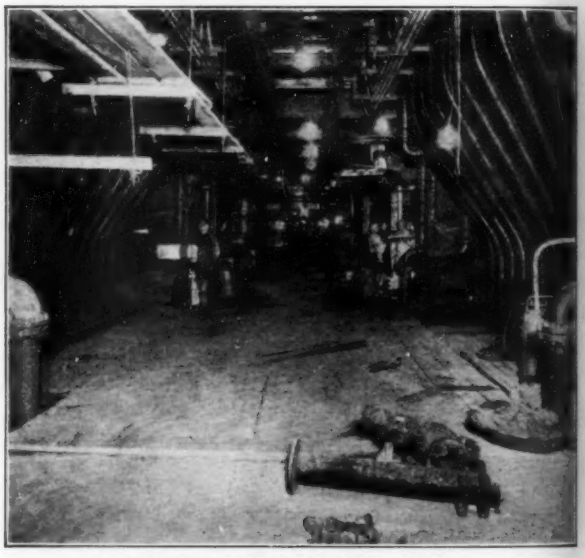
CENTRIFUGAL CINDER CATCHERS

The gases pass from the boiler through a preheater, a wet dust catcher, and thence to centrifugal dust catchers on the roof



ONE OF THE GREAT FANS

Huge fans, such as the one illustrated, are used to force air into the preheaters and from there into the hot air downtakes

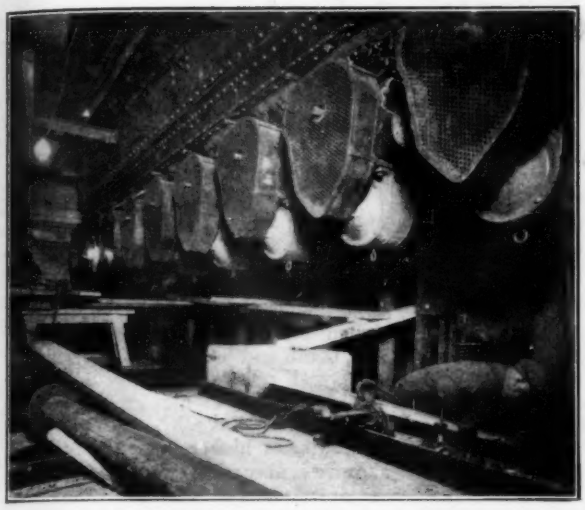


PIPES FOR PULVERIZED FUEL

It is through these pipes that the pulverized fuel is fed to the boilers. The coal used is previously pulverized in a mill house

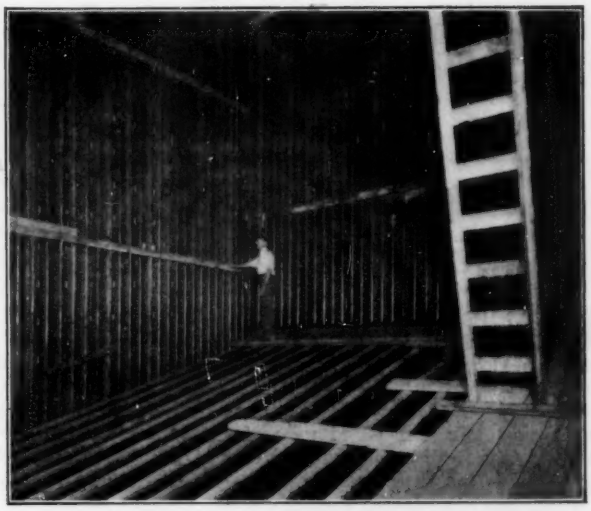
Power Plant to Generate 1,000,000 Kilowatts

The East River Generating Station of the New York Edison Company was designed by Thomas E. Murray, Inc., associated with the engineers of the owning company. This station will supply 25-cycle current at 11,400 volts to the Edison System, and will also provide means of "tying in" the Edison 25-cycle system with the United Electric Light and Power Company and the Brooklyn Edison Company's 60-cycle systems, through large frequency changers. When completed, the plant will occupy an area 1092 feet long by 206 feet wide and will have a capacity of approximately 1,000,000 kilowatts. The present building is approximately 354 feet long by 206 feet wide. The property affords suitable accommodations in the main structure for nine steam turbines; the first two, already installed, have a capacity of 60,000 kilowatts each. Succeeding units will probably be of larger size, as 150,000 kilowatt single-shaft units can be accommodated, bringing the ultimate capacity of the plant to over one million kilowatts. There is also adequate provision for a mill house for pulverizing the coal and for sufficient coal storage. We have already dealt with the generating units and their accessories in the issue for November, 1926. Some years ago, Thomas E. Murray, in an endeavor to increase the steam-producing capacity of power-house boilers and decrease the cost of furnace maintenance, conceived the idea of a completely water-cooled boiler-furnace wall of improved design, completely eliminating the use of fire brick and refractories with their attendant rapid deterioration and high repair cost. This design has been given a thorough test at the Hell Gate Station, with most satisfactory results and, with subsequent improvements, now forms the basis of a



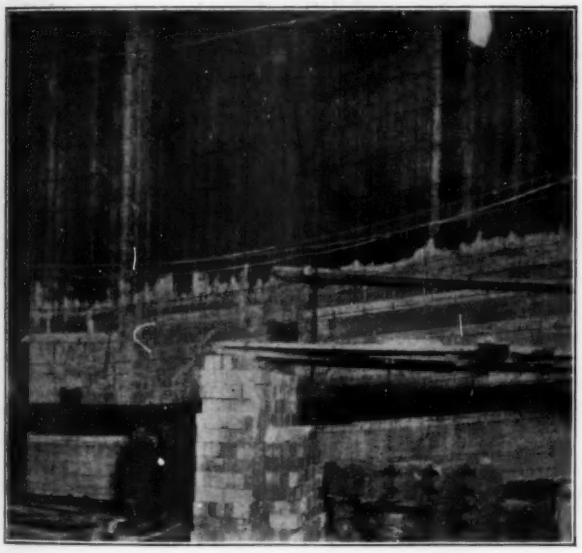
MOTOR-DRIVEN COAL PUMPS

These are motor-driven pumps which force the pulverized coal through the various pipes and burners and into the boilers



THE WATER-TUBE WALLS OF THE BOILER

The furnace wall is water-cooled so that the use of fire brick and refractories is done away with, thus avoiding deterioration



INSULATING THE OUTSIDE OF THE BOILER

To keep in the heat, the outside of the water-tube walls of the huge boiler must be insulated by fire-resisting substances

THE BOILER COMPLETELY COVERED

Insulation is complete and the boiler is ready for "blowing-in" at a pressure of three hundred and seventy-five pounds

unique and epoch-making steam-generating unit of enormously increased capacity, low maintenance and labor costs and high efficiency. The boilers have a normal commercial rating of 50,000 pounds of steam per hour, but with these improvements they can be operated at continuous overloads, so as to produce 250,000 pounds of steam per hour—something like 500 percent of their rating. They are of the cross-drum type with the boiler tubes inclined at about 15 degrees to the horizontal—the unique feature being the enormous combustion chamber, which is entirely enclosed in water-cooled walls. The boilers are provided with steam superheaters, and preheaters supply hot air for combustion, the hot air being injected with the powdered coal. Draft requirements are provided by means of forced draft through the air preheaters and induced draft to the stack. The flue gases are washed in a wet washer or cinder catcher and then passed through enormous centrifugal cyclones, which catch the fine dust before the flue gases are finally delivered to the colossal stacks 375 feet high by 22 feet in diameter. There will be seven of these in the completed station. Disposal of the dust and ashes is provided for through a hydraulic flushing system. The pulverized coal received from the grinders in the mill house is forced by air pressure through transorting pipes across the connecting bridge into the individual bins of the boiler house, located above each boiler. From here it is picked up by the feeders and, with the compressed air from the primary air duct, the current of powdered fuel is forced into the furnace through the burners. The small amount of slag falls between the tubes forming the water screen located at the bottom of the furnace, and is precipitated into the ash pit, to be finally drawn out into the ash-discharge conduit. The gases resulting from combustion pass out of the boiler through the uptake, into an air preheater and into the wet type primary dust catcher. From this point the gases pass through the induced-draft fans to the secondary dust catchers or centrifugal cyclones, located on the roof of the boiler house. From here the gases pass into the main flue and then into the stack.

The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

A Family with Low Blood Pressure

DR. JOHN D. GARVIN of Pittsburgh has recently reported six cases of low blood pressure in one family. The family is characterized by extreme activity, efficiency, hard work and splendid physique and is noteworthy for its longevity. Nevertheless, the blood pressures were very close to 100 in all cases; the highest recorded was 108, with the diastolic blood pressure varying from 66 to 70.

More and more physicians are coming to attach little significance to relatively low blood pressure, provided the patient does not have other signs or symptoms of importance. The conviction is increasing that high or low blood pressure may frequently be an hereditary phenomenon. Much more significance, however, is attached to high blood pressure from the standpoint of its relationship to disease.

The Brains of Prehistoric Men

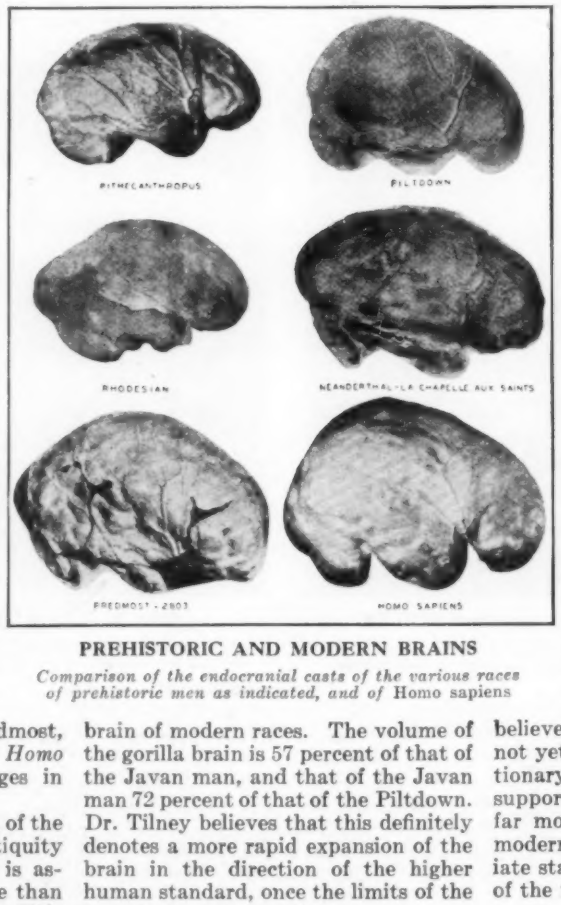
UNQUESTIONABLY the brains of men have been modified as they have progressed from the earliest time to the present. Recently Dr. Frederick Tilney of New York has made a study of the psychologic foundations of human progress, comparing the brain capacity and brain structures of the earliest man with those of the anthropoid apes and with modern men. It is generally well known to scientific readers that the skulls of *Pithecanthropus erectus*, Rhodesian, Predmost, Piltdown, Neanderthal and *Homo sapiens* represent varying stages in human progress.

Dr. Tilney finds that the brain of the Pithecanthropus, to which an antiquity of not less than 500,000 years is assigned, is of a much higher type than that of any of the great apes. This species has been called the "ape man" of Java and has been popularly referred to as the "missing link." Its frontal lobe is larger than that of the gorilla. The left lobe of the Javan man is slightly larger than the right, which Dr. Tilney believes indicates unidexterity. On the other hand, as compared with the brains of modern races, that of the Pithecanthropus resembles the brain of a three-year-old child.

Apparently the early ape man was capable of some advantageous reasoning, was right handed and had probably learned to speak. The means of communication are of first importance in the foundation of human knowledge.

The Piltdown skull has a volume about that of the gorilla, but much below that of the average adult human brain of modern races. The volume of the gorilla brain is 57 percent of that of the Javan man, and that of the Javan man 72 percent of that of the Piltdown. Dr. Tilney believes that this definitely denotes a more rapid expansion of the brain in the direction of the higher human standard, once the limits of the ape state were passed.

Apparently the Dawn Man lived in a community of considerable size and was capable of performing skilled acts. Apparently he was dependent for his livelihood on game. He used his implements only for food and for protection, but did not use them for cultivating the soil, for the production of clothes, or for the construction of permanent dwellings.



PREHISTORIC AND MODERN BRAINS

Comparison of the endocranial casts of the various races of prehistoric men as indicated, and of Homo sapiens

Neanderthal man made definite advances in human progress. He was a skilled artisan and flint-worker. He had command of fire; he buried his dead with ceremonial rites, which indicates a belief in a future existence. He seems to have had many of the attributes of higher man. His brain shows a still further expansion in all its major divisions. Nevertheless, his frontal lobes still have anthropoid tendencies, as shown by the projecting eye sockets, the low receding brow, and the broad nasal openings. Thus he had a definitely gorilla-like appearance.

As the frontal lobes of the brain enlarge, the orbital plates flatten, the enlargement of the frontal lobe having to do with the appearance of a higher intelligence. The cerebrum of man is that portion which gives him the capacity to develop, inculcate and transmit cultural activities. Man has grown in humanity as his brain has expanded. The outline of this development of the brain made by Dr. Tilney and published in the *Archives of Neurology and Psychiatry* is a highly technical account but is so logically developed as to lead definitely to the view that the frontal and prefrontal regions of the brain are of the greatest importance in differentiating man from the lower species. In the process of evolution they have developed progressively from the earliest Pleistocene epoch. Dr. Tilney believes that the human cerebrum is not yet a finished product. "Its evolutionary history," he says, "does not support this view, but makes it appear far more probable that the brain of modern man represents some intermediate stage in the ultimate development of the master organ of life."

Physical Defects In a Thousand Children

DR. WILLIAM R. P. EMERSON, professor of diseases of children in Tufts College Medical School in Boston, has recently tabulated the defects found in a thousand children. They included three rather distinctive social groups—the first, 245 dependent children in a charitable home; the second,

357 children seen in a clinic; the third, 398 children from well-to-do families who were observed in private practice.

It was found in this study, as compared with a previous investigation made in 1921, that the care of the teeth has made great progress during recent years, particularly among the well-to-do. However, the care of the teeth is also receiving increasing attention among the middle class and among the poor, since the teeth were found to be much better in general in the children examined at this time as compared with the thousand studied six years ago.

The investigation revealed from four to six physical defects in each child, including inflammations of various types, bad posture or physical abnormalities. About 50 percent of the disturbances were associated with the nose and throat, and about 30 percent of them were bad posture. The well-to-do families averaged 4.6 physical defects of all kinds and 1.8 due to nose and throat defects; the poor children, 5.2 physical defects of all kinds, and 2.5 due to nose and throat defects; the middle class, 6.8 defects of all kinds with 3.5 due to nose and throat defects.

Medical Research on Mummies

DR. ARNOLD SACK of Heidelberg recently reported in the *Munchener Medizinische Wochenschrift* the results of examinations made of Egyptian mummies with a view to determining the diseases from which they may have died. A mummy of the nineteenth dynasty had a typical club-foot. Many of the mummies were found with fractures of the bones or with relics of fractures, sometimes held in place with artfully contrived splints.

Stones were found in the bladder of mummies dating back to periods preceding the first dynasty. Kidney stones were found and also a case of tuberculosis of the spine. Ulcers with cancerous changes were observed, as were almost every type of condition now recognized by the modern science of pathology.

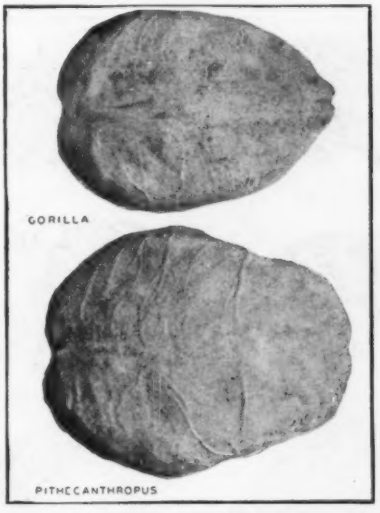
It is interesting to know that the teeth of the mummies were in general good, particularly in the poor population, but that the teeth of the kings were badly decayed in many instances and this applied as well to the teeth in 500 bodies of Egyptians of the highest class.

Students of the history of syphilis are divided into two groups, one of which believes that this disease existed since the earliest times, whereas the other is convinced that its first appearance in Europe dates from the discovery of America. Changes indicative of this disease were not found in the mummies, although 30,000 bodies were investigated.

Life Expectancy

IT is rather well established that the life expectancy of the individual has increased from 35 years in 1825 to 55 years in 1925. In this connection it is interesting to cogitate on the life expectancy of individuals in the earliest times. Geologists, archeologists and paleontologists estimate the age of the world varying from one hundred thousand to five hundred thousand or millions of years. Relics of ancient man have been studied with a view to determining his age. Apparently few men died of old age in early times. Indeed, the best evidence available indicates that early man seldom lived to 30 years of age. The exigencies of human existence in the savage state were such as to bring about an early demise.

Professor Todd of the department of anatomy of Western Reserve University of Cleveland has made a study of ancient bones with a view to determing this point. It is known, for example, that the epiphysis of the bones continues to form until some 30 years of age, and that sutures between bones ossify and close up from 30 to 45. The bones of the very old have other marks that aid a decision. Regardless of the patriarchs referred to even in the Bible, there is no reason to believe that ancient man lived very long. Modern knowledge and the conditions associated with modern civilization have added certainly 25 years to the average existence. With us today, sexagenarians are common and octogenarians are not infrequent.



ANOTHER COMPARISON

These are endocranial casts of the superior surfaces of the brains of a gorilla and of Pithecanthropus erectus

Skin Eruption from Linseed Oil

AN industrial physician who worked for many years in the paint industry noticed that skin disease was quite frequent among workers in the linseed-oil mill. These people had areas on the hands and feet which were frequently subject to itching and burning. In an investigation of this matter in the entire linseed-oil industry, it became clear that such cases appear in hundreds among such workers. The seeds from South America are more irritating than those from Canada or the northwest states, and those from India are even more irritating. The eruptions are usually on the forearms and hands, but appear occasionally on the neck, shoulders, chest and upper back. When the worker discontinues his work for three or four days the irritation promptly disappears.

In many instances the eruption followed the wiping of the oil and linseed meal from the hands and forearms with burlap, which is itself rough and irritating and frequently contaminated with infection.

Another investigator was convinced that the inflammation was caused chiefly by the dust from the flaxseed. He stated that he had seen 400 cases in the mill in which he had worked for a period of five years.

It is said that blonds suffer more with this condition than do people of darker complexion. A study of the appearance of this type of diseases in various mills leads to the definite opinion that contamination with the irritating substances produces the eruption, although the exact nature of the irritating substance is not yet known.

Milk from Stall-Fed Cows

MILK supplied by dairies in various parts of the United States differs as to its content of vitamins. Some of the milk comes from cows that are stall-fed the year 'round. The milk from pasture-fed animals has been reported by most investigators to be richer in vitamins than that from animals without access to pastures. Dr. Florence L. MacLeod of New York has made a study of the value of the milk of the pasture-fed cow as compared with that of the stall-fed cow, particularly as it relates to the content of vitamin C, the vitamin that is concerned with the prevention of scurvy. Apparently the ensilage, which is the principal source of the anti-scurvy vitamin in the food of stall-fed cows, contains a considerable amount of this substance.

Dr. MacLeod's investigations revealed the fact that stall-fed cows that are given a well balanced, uniform diet throughout the year provide a milk which does not vary from season to season in the antiscurvy vitamin. In this connection, it is interesting to note that attempts are already being made to produce vitamins in milk by means of irradiation with ultra-violet rays.

Ice That Melts To A Gas

As A Refrigerant, Solid Carbon Dioxide Offers Many Advantages To Various Industries

By D. H. KILLEFFER

CAN you imagine obtaining cold from a moth ball? Probably not, and even if you could imagine such a thing, the penetrating odor of naphthalene would certainly not appeal to your esthetic sense as a thing to be lightly mixed with food. Yet in a way, exactly the same thing that happens to a moth ball among the blankets in summer, occurs to the newest of portable refrigerants, solid carbon dioxide, when it is at work making cold. A few things have the valuable property of evaporating directly from a solid crystalline mass to a gas and as every student of physics knows, evaporation absorbs heat, which is merely a correct way of saying that it produces cold. Naphthalene and camphor can pass from a solid to a gas without becoming a liquid in the meantime, or leaving any residue. This property of evaporation makes them valuable for driving away the insects that would devour our winter coats and blankets if given a chance. If these chemicals evaporated faster and were less odorous they might very well be used in the ice box.

SOLID carbon dioxide, produced by mechanically freezing the same gas which imparts "fizz" to soda water, evaporates rapidly enough from a solid mass to a gas to be a useful cold producer. Unlike moth balls and camphor, it possesses no odor and produces no harmful effect on foods. Pound for pound it absorbs much more heat in evaporating than ordinary ice does in melting and there is no water or other liquid to be drained away from the cooled space.

One must not confuse the subject of this discussion, which is to all intents and purposes a new kind of ice, with the numerous mechanical refrigerators for home use now on the market, which are no more than working miniatures of ice-making machines and cannot be removed from their source of power. Solid carbon dioxide is essentially portable and while it requires special handling to bring out its best efficiency, it is merely a very cold kind of ice.

This convenient new refrigerant is the latest thing to send a shiver of apprehension up the spine of the refrigerating industry. The tremor along that same spine caused by the general introduction of fool-proof mechanical refrigerators into the family ice box has hardly died out when another, which may be even more serious, is started merrily on its way. Of course, the icemakers quieted the first fearful chill with the more or less coolly comforting thought that ice could be carried from place to place much more easily than a mechanical contrivance for making it, so that a large and growing part of their business, refrigeration of perishables in transit, would not be bothered. But that cannot be said of solid carbon dioxide, which is in most respects just like ordinary ice. That is a different story. How different, time alone will reveal, but the facts of the first chapter certainly intrigue one's interest in the history that is still to be made.

All illustrations courtesy Dry Ice Corporation of America

FROZEN FISH AND DRY ICE

Frozen fish are safely transported by placing boxes of solid carbon dioxide throughout the car containing them. The refrigerant is packed in wooden boxes quite like those containing the fish

Solid carbon dioxide, the laboratory curiosity shown to students of physics and chemistry for more than half a century, is difficult to consider new, but this plaything of the laboratory and the lecture table has now gone so far as to threaten a revolution in methods of long-distance transportation of foodstuffs. One is not inclined to attach any great significance to the laboratory stunt of blowing liquid carbon dioxide into a canvas bag to form a very cold snow, with which liquid mercury may be frozen to a solid hammer. But when a similarly simple operation is applied economically in industry and tons of this snow are made and used every day; when by its use so perishable a commodity as ice cream can be economically transported from New York and Philadelphia to the warm climate of Cuba in such large quantities as to bring the threat of an embargo on its import; and when carloads of frozen fish can be shipped by rail on a five days' journey without re-icing and without thawing, the situation becomes essentially different. One must recognize that the elements of an industrial revolution are present. However, just how extensive this revolution may be, what fields it may ultimately touch, and what economic structures it may seriously affect or overthrow, one can only guess.

AN ancient recipe for rabbit stew began with the wise injunction to catch the rabbit first. That is a proper beginning for a description of the making of solid carbon dioxide, for, although there is no other single waste of industry that is comparable to the huge tonnage of carbon dioxide daily vented from our chimneys, there are few more difficult to "catch." The burning of any material containing carbon, with plenty of air, produces carbon dioxide, and, after properly washing out the soot and impurities of ordinary flue gas with water, the carbon dioxide may be absorbed in a cold solution of sodium or potassium carbonate. Heating of this solution under pressure releases the pure gas, which can then be liquefied by cooling and compressing to 1100 or so pounds per square inch.

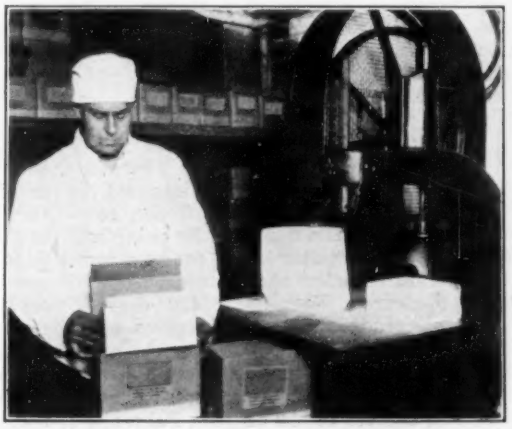
The difficult part of this is that the process requires more energy by nearly 200 percent than can be obtained from the coke that is burned to produce the carbon dioxide. In other words, the burning of coke produces three times as much carbon dioxide as the heat generated by it will serve to compress and liquefy. That, of course, is the reason why power plants cannot now recover this increasingly valuable waste from their flues.

Having the liquid, there is no trouble about getting the solid. All one needs

to do is to allow the liquid to escape through a small orifice and catch the snow as it is formed. For longer than anyone cares to remember, it has been a standard demonstration in most classes of chemistry and physics to invert a cylinder of carbon dioxide and allow the liquid to escape through the opened valve into a canvas bag. Afterward it is found that the bag contains a very cold snow of pure carbon dioxide. In present commercial practice, the principle employed is exactly the same, with the exception that the snow produced is compressed into solid blocks by pressures of 500 to 800 pounds per square inch. Refinements of the operation increase the yields of solid but there is no essential difference.

THAT briefly is the story of making solid carbon dioxide, which has often intrigued the fancy of inventors. We must now consider the reason why it now is successfully used here after so many failures abroad. The growing necessity for transporting perishable foodstuffs over long distances, requiring several days by rail, has led to the development, in the United States, of extensive systems of refrigerator cars, based naturally upon water ice, and along with this development has come the further need for frequent re-icing stations for cars en route, to assure the delivery of their cargoes in first-class condition. No comparable systems have been developed abroad to furnish ready outlets for portable refrigeration and the failure of foreign inventors to recognize the specialized peculiarities of solid carbon dioxide in use foredoomed their attempts to commercialize it. With a huge potential market for a thing of the kind already in existence, and with methods of application developed to the point of making competition possible with the only existing portable refrigerant, frozen water, the possibilities of the new industry are very great.

The value of the new refrigerant depends primarily upon two important facts: solid carbon dioxide evaporates directly from a solid to a dry gas and in so doing it absorbs an amount of heat nearly double that absorbed by the same weight of ice in melting. By taking full advantage of these two considerations in its use, one pound of solid carbon dioxide can be made to serve the same purpose as 15 pounds of ice in producing temperatures below freezing. Since its cost on the present limited scale of production is only about ten times that of ice, there is reason to expect much from it as the expansion of its manufacture brings its price down. Probably its greatest advantage is in the fact that a dry gas is produced direct and there is no liquid, carrying potential cooling capacity with it, to be drained away. The second great advantage is in the high heat-absorbing capacity of carbon dioxide in passing from the solid to the gaseous state—carbon dioxide absorbs approximately 275 British thermal units per pound in passing from the pressed cake to gas at 32 degrees, Fahrenheit, in contrast to ice which absorbs only 144 British thermal units per pound in melting at 32 degrees, Fahrenheit.



MAILING-PACKAGES FOR DRY ICE

Blocks of solid carbon dioxide are cut on ordinary wood saws to convenient sizes for inclusion in mailing packages containing ice cream and other frozen delicacies. The solidified gas will keep ice cream frozen for several days in the mails

THE evaporation of the solid carbon dioxide directly to a gas has a peculiar value, of which advantage is taken in refrigeration practice. The atmosphere of the refrigerated space is constantly replaced by fresh, pure, cold, dry carbon-dioxide gas, which is quite harmless to products stored in it and is indeed considered to be an actual preservative of many foodstuffs. Each pound of snow evaporated yields about eight cubic feet of gas, which is allowed to fill the refrigerated space and to overflow from vents situated as near its top as practicable. In this way any accumulation of odors in the stale air which would be confined within an ordinary refrigerator is avoided, and in addition, the heat leaking through the walls is absorbed and vented along with the gas overflow. By venting the heat leakage in this manner, it is unnecessary for the refrigerant to absorb it and thus the amount of evaporation needed to keep a cold space at the desired low temperature is only that required to keep up a flow of gas through the vents large enough to carry the heat leakage with it, the gas

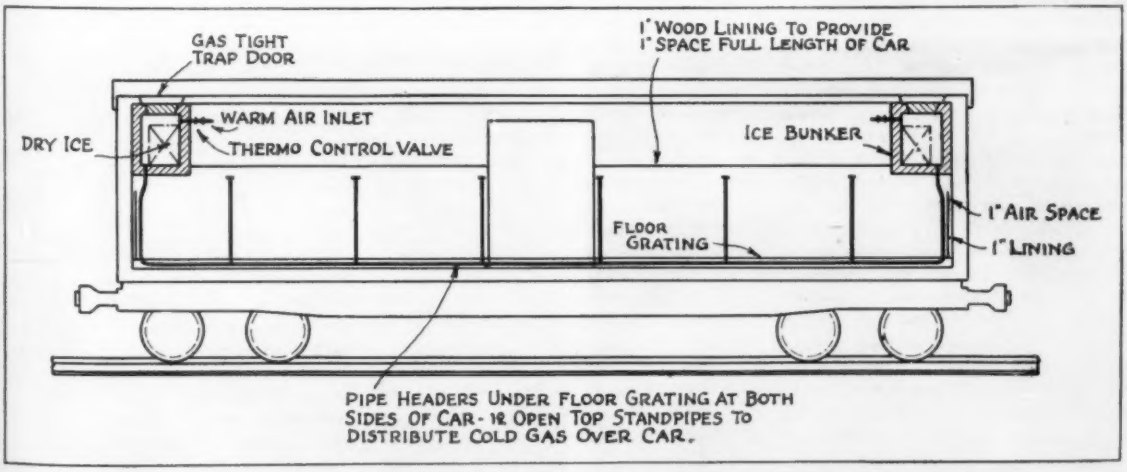

GAS TIGHT TRAP DOOR
1" WOOD LINING TO PROVIDE 1" SPACE FULL LENGTH OF CAR
WARM AIR INLET
THERMO CONTROL VALVE
DRY ICE
ICE BUNKER
1" AIR SPACE
1" LINING
FLOOR GRATING
PIPE HEADERS UNDER FLOOR GRATING AT BOTH SIDES OF CAR - 12 OPEN TOP STANDPIPES TO DISTRIBUTE COLD GAS OVER CAR.

DIAGRAM OF ICING ARRANGEMENT OF REFRIGERATOR CARS

This drawing illustrates the method of equipping a refrigerator car for the use of dry ice where the cargo would be damaged by freezing. The cold CO_2 gas generated by the melting of the solid is conducted through the cargo in pipes, and is allowed to fall over the perishables. The bottom of the car is sealed and gas is allowed to escape only through traps in the top of the car. No other ventilation is permitted, and thus the circulation of cold gas is maintained

passing out at the maximum temperature of the space. In other words, the incoming heat is carried out at the highest possible temperature, which may be decidedly higher (150 degrees, Fahrenheit or more) than the temperature of the evaporating solid itself. The case of water ice is quite different, for the liquid water leaving the refrigerator is at or near the temperature of the melting ice itself and hence must remove heat at the lowest feasible temperature differential, and in addition there is always the accumulation of undesirable odors in the necessarily confined air.

IN spite of its very low temperature —the internal temperature of a block of carbon-dioxide snow in an atmosphere of the same gas is about 112 degrees below zero, Fahrenheit (80 degrees, Centigrade)—the product is remarkably long-lived under most practicable conditions. The explanation of this phenomenon of slow evaporation appears to be the presence within the cake itself of gas-filled voids making up about one fourth of its volume and the formation all around it of an insulating layer of cold gas. The heat conductivity of the somewhat porous block is very low as compared with a solid block such as one of water ice, and hence it is difficult for heat to penetrate it. The blanket of cold gas constantly surrounding the evaporating block prevents its contact with warm air, and possibly even its direct contact with a heat-conducting solid upon which it may rest, a situation quite different from that of water ice, which on account of convection currents is in constant contact with air much warmer than itself.

The very high heat-absorptive capacity of the evaporation of solid carbon dioxide to gas makes it especially fortunate that these natural forces can be utilized to make the process a slow one. While the temperature of evaporating solid carbon dioxide in an atmosphere of its own gas is -112 degrees, Fahrenheit, if the block is placed in air its temperature can be reduced still further to -139 degrees, Fahrenheit. This effect of reducing the vapor pressure of the carbon dioxide in the atmosphere surrounding the solid can be used to advantage where rapid cooling to very low temperatures is desired.

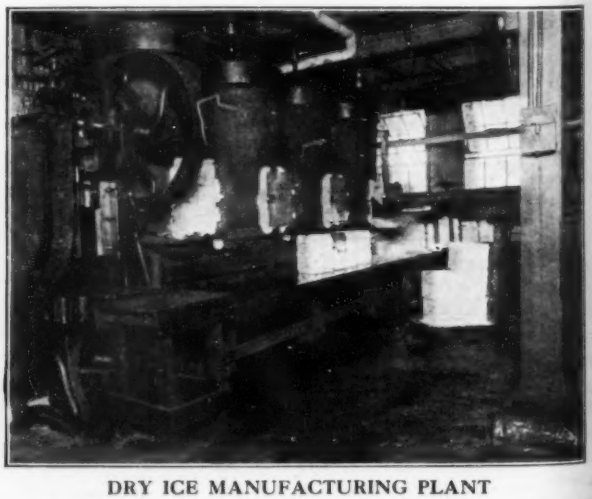
THE low temperature of evaporation of the carbon-dioxide snow provides a valuable factor of safety as compared with water ice, where low temperatures must be maintained, as in the transportation of frozen commodities. The necessity for using salt along with water ice to produce temperatures below the customary one of 50 degrees, Fahrenheit (10 degrees, Centigrade), not only involves additional labor but also reduces the overall efficiency of the refrigerant. With carbon-dioxide, temperatures as low as -40 degrees or -50 degrees, Fahrenheit may be attained with reasonable efficiency and at much higher efficiencies than freezing temperatures with ice and salt mixtures. Indeed, probably the most important field for carbon-dioxide ice is in those temperatures below the melting point of ice so often required in commerce, as in the transportation of frozen meats, fish, ice cream, et cetera, for its efficiency is much higher than that of water ice below 32 degrees, Fahrenheit. In all cases where freezing might be deleterious to the material to be cooled, the carbon-dioxide ice must be carefully insulated so that only the gas evolved (having a specific heat of approximately 0.2) comes into contact with the material and that even then it be diluted considerably with the warmer gas in the upper parts of the refrigerated space.

The most spectacular use of solid carbon dioxide, which is not at all competive with any other refrigerant, is the cooling of small parcels of ice cream in paper containers to be sent by express or mail or otherwise carried for considerable distances. The weight of the refrigerant is small, its rate of evaporation slow, the product of its cooling action is a harmless gas and not a more or less disagreeable liquid, the weight of container and necessary insulation is small, and it is capable of keeping the contents of the package cold for as much as 36 to 40 hours without difficulty. Its application to less than carload shipments of many commodities, obviating as it does the return of heavy empty containers and at the same time the necessity for reicing en route, has proved very economical. Cans of ice cream may be readily shipped with solid carbon dioxide packed around them in padded canvas bags, which are decidedly lighter than the heavy tubs required for ice and salt. This system is illustrated below.

THE evaporation of carbon dioxide to a dry gas not only makes feasible its use in paper or cardboard containers for small-lot shipments without the necessity of the return of empty tubs or barrels, but for carload freight it also reduces the maintenance cost on refrigerator car equipment. The depreciation of refrigerator cars in service is very rapid, largely because of the moist cold supplied by water ice and the brine drippings from ice bunkers which must be cared for. There is also the possibility that drip pipes may become clogged and water collect around the cargo, resulting in serious damage. There may, too, be some advantage in avoiding the drip of brine and ice water onto rails and ties, thus reducing corrosion and the cost of maintenance of way.

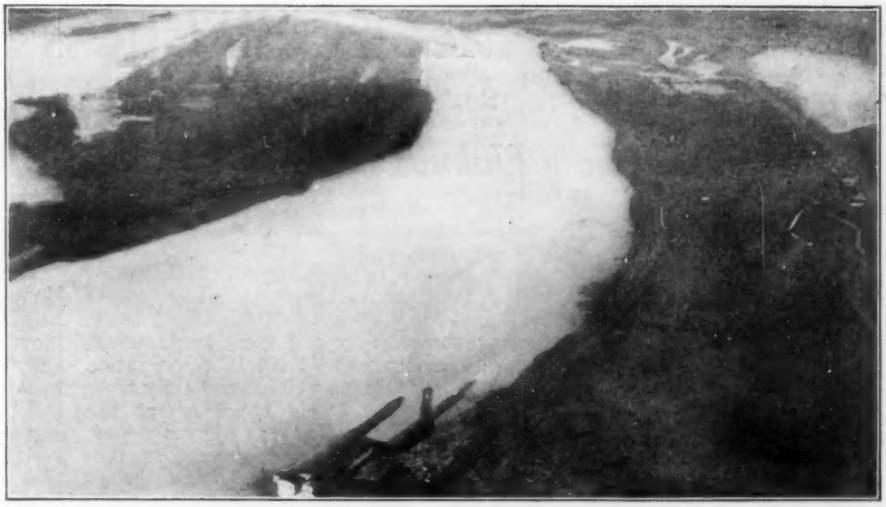
CONVENIENT PACKING OF ICE CREAM

Blocks of dry ice, packed in heavy padded canvas bags, together with cans of ice cream, make transportation simple



DRY ICE MANUFACTURING PLANT

Here are shown the evaporators and hydraulic presses for forming the blocks. Some finished dry ice is on the bench



BEFORE DREDGING

Swan Island, at Port of Portland, Oregon, before the dredging operations. To the right of the island is the original ship channel leading to the city. Swan Island for many years forced the main flow of the Willamette River into a narrow and crooked channel lying in the stretch of water between the island and the shore on the right. The Port Authorities possess some of the most powerful dredges in the world, and these had done much notable work in filling waste and swampy lands. They were used in dredging away the portion of the island to the left and forming a new channel on that side as shown below

ISLAND AS AIRPORT

In the original plans, it was decided to dredge away the island on one side, and deposit the material on the right-hand side. It was intended to use the island as a terminal site for freight, and there was some thought of constituting it as a free-port area. Subsequently, the inauguration of the coast-wise air mail, and the increasing general interest in aeronautics created a demand for an airport as part of the city's terminal facilities. The Port Authorities accordingly made the new Swan Island into an airport, which is shown on the illustration by the smooth surface, which is 6000 feet long by 1224 feet wide

Building an Airport With Dredges

Swan Island, at Portland, Oregon, has for many years forced the main flow of the Willamette River into a narrow and crooked channel, where marine disasters were frequent. As part of its general plan for improving the harbor at Portland and the approaches thereto, the Port Commission determined, some time ago, to remove the island and open a new, straight channel, using its powerful suction dredges for the purpose. As the plans were worked out, it developed that the entire island would not have to be removed. The commission's engineers decided to dredge away the island on the side away from the existing ship channel, pump the soil across it, and deposit it on the side adjoining the ship channel, thus literally turning it over into a new position in the stream. The new land was to be used as a freight terminal site. The recent inauguraton of the coastwise air mail created a demand for an airport as part of the city's terminal facilities. The mail, flying over the city, was compelled to land across the Columbia River at Vancouver, Washington, ten miles distant. This involved a delay of approximately 40 minutes in distribution of Portland letters. Swan Island, it appeared, would not be needed for some time as a terminal site and it was agreed by the commission and the aerial leaders of the commnity that it offered an ideal site for an airport. The airport will rise about five feet above the high water level of the river. It will be slightly over 6000 feet long by 1224 feet wide. Its longer axis directly parallels the prevailing winds at Portland. The projected causeway will permit construction of a 5000 foot runway at an angle of 45 degrees to this axis and this will parallel virtually all the other winds experienced there. Thus landing and take-off may be made directly into the wind at all times, in spite of the comparative narrowness of the airport. The airport will have a number of advantages. Among these are easy visibility from the air, even in thick weather, ease of access (there being no obstructions in the aerial approaches), and better meteorological conditions than at any other location in the Portland area. Also, it will be but one and a half miles from the city. Buildings and service arrangements on the island will be of the most approved types. Use of neon tubes for marking the boundaries of the field, and other highly modern appliances are under consideration. Six batteries of floodlights are planned to make the field available for use during the night hours. "We have plenty of money and will spend whatever is needed to make this a first-class field, available for use 24 hours every day," said J. H. Polhemus, chief engineer of the commission. The estimated cost of the airport is 1,250,000 dollars. In moving the island, about 30,000,000 cubic yards of material were handled by the four dredges operated by the Port Commission. The work occupied more than two years. Simultaneous dredging of the channel and building of the airport lowered the cost of each.

Sleepy Sickness

Epidemic Encephalitis, or Sleepy Sickness, is Apparently a New Disease Whose Unknown Cause is Being Sought by Science

By SIMON FLEXNER, M.D.
Director, the Rockefeller Institute for Medical Research, New York

The Author

BEFORE the close of the war, in the late winter of 1918, a curious nervous disease appeared in England and France. Both countries were at the time suffering from food shortage, and the populations were therefore on a rationing system. In England for the first time canned, or as they are there called, "tinned" foods came into wide use. It was known that spoiled canned foods sometimes contain a peculiar poison of bacterial origin, which induces botulism in man, a severe and often fatal form of food poisoning attended by certain nervous symptoms, of which paralysis of the muscles of the eye forms a part.

THE cases of nervous disease which became exceedingly prevalent in the early months of 1918 were attended by paralysis of the muscles of the face, including those of the eye. In the absence, therefore, of previous experience with an epidemic disease of this character, the confusion of the disease with botulism is perhaps excusable.

But there was a second and even more striking attendant of the disease unknown in connection with botulism, namely an overpowering lethargy or tendency to sleepiness. The victims of the disease would fall asleep under extraordinary and most inconvenient circumstances—while in conversation or at table, as well as over daily tasks or lessons. This happened at the onset of the disease; as it progressed, the lethargy would become so profound as to keep the patients asleep for many consecutive days. While in this deep slumber, they could be aroused momentarily to receive food or other attentions, but would take no interest in their surroundings and would again fall at once into slumber.

EFFECTS OF EPIDEMIC ENCEPHALITIS

The mouth is drawn to the right and the right eyeball has become more prominent than the left

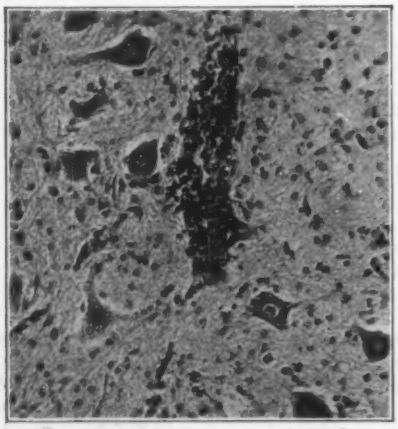
The outcome of the cases varied very much. A quarter or more succumbed before the stage of lethargy passed; another fraction gradually regained normal consciousness and were restored to health; another fraction recovered only partially, becoming victims of chronic disease of the nervous system, often of very serious character.

With the close of the war it became apparent that not only England and France, but other countries also had experienced this remarkable disease. Indeed, it was discovered that a Viennese doctor by the name of von Economo had published in 1917 a description of a series of cases coming under his observation, for which he had invented the name of "lethargic encephalitis," the word encephalitis meaning an inflammation of the brain, evidences of which had been observed in cases terminating fatally that had been examined *post mortem*.

The Viennese cases were readily identified as being identical with the English and French, and the view prevailed that the disease which was new to the western world probably had long existed in the East. This belief has not been upheld by precise studies carried on since then, and the view that the Viennese cases were the first to be observed is now no longer held, since it has become known that an even larger series had been observed in 1916 by Cruchet and others in the invalided French soldiers in the neighborhood of Bar le Duc.

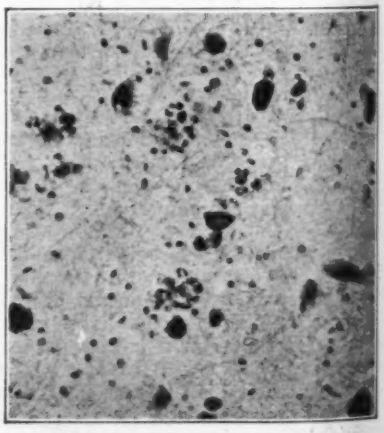
THE first cases of the disease appeared in the United States a year later than they arose in England, or in 1919. Between 1919 and 1926, the disease spread widely throughout America and many hundreds, or even thousands, of cases occurred. Within this period, many cases arose in Europe and others were reported from Asia, China and Japan. In 1924, a severe epidemic outbreak raged in Japan, in which 7000 known cases with nearly 4000 deaths occurred. With the passage of time and the recognition of the tendency to mass outbreaks of the disease, the name epidemic encephalitis has practically displaced the earlier one applied by von Economo.

Another reason exists for the change



EFFECT ON THE SPINAL CORD

Microscopic section of the upper spinal cord in a case of epidemic encephalitis. A blood vessel is almost occluded by an abnormal collection of lymphocytes



DEGENERATED NERVE CELLS

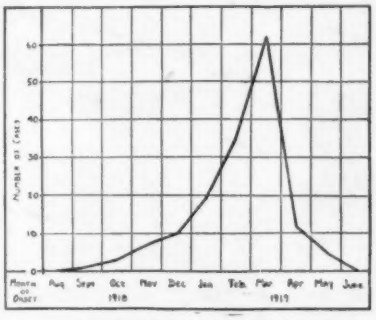
Photomicrograph of the black substance of the brain, showing degenerated nerve cells invaded by phagocytes, a special variety of the leucocytes of the blood

in name. The first cases of the disease observed in all the countries involved were of the lethargic or sleepy character. It was the English who gave the name "sleepy sickness" to the affection, to distinguish it from the well-known African disease called "sleeping sickness." The two diseases are entirely distinct in origin: the African disease is caused by a parasite, a trypanosome, carried by the biting tsetse fly, and is visible under the microscope; while the microbic source or incitant of sleepy sickness is unknown.

IN contradistinction to the sleepy cases, many cases of an opposite type have now come to be distinguished. Instead of the main symptom being lethargy, it is in this case overmuscular, sometimes overmental, activity. If the one class of cases is spoken of as hypokinetic, the other may be, as indeed it is, called hyperkinetic. Many hundreds of these hyperkinetic cases have been described. It is not difficult to account for both kinds of cases on the basis of what is known of the localization of function in the brain. According as the inflammation attacks chiefly one anatomic and physiologic region or another, there will result either lethargy or overaction. Sometimes both processes follow one another in patients in whom the inflammation is progressive, involving different parts of the brain in succession.

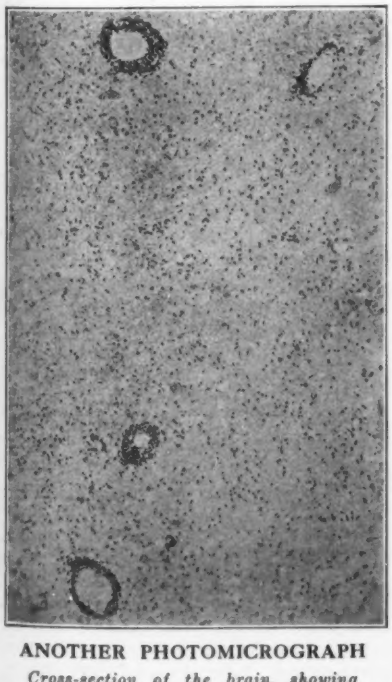
Now that a number of years have elapsed since the disease reached world-wide, or as we call it, pandemic extension, abundant opportunity has occurred not only to ascertain its toll as measured by death and recovery, but also the consequences as determined by its after effects. The mortality has ranged from 25 to nearly 60 percent, according to time, place, and the number of persons attacked. The highest recorded mortality seems to be that of the Japanese epidemic of 1924.

A very serious aspect of the disease arises from the sequences or late effects. While the paralyzed muscles of the face usually recover their action, those of other parts of the body may not do so. But the paralytic residues of encephalitis are far fewer and are less severe than in poliomyelitis or infantile paralysis. The serious sequences are of another sort, namely as influencing the mental traits of the victims, to the extent of modifying profoundly their character, or of the kind which lead prematurely and frequently to that over-rigid state of the general muscular system to which the name of Parkinson's disease, or paralysis agitans, is given. The fact is now being recognized that many instances of insubordination and recalcitrancy among children and young offenders against the law, have been victims of epidemic encephalitis, from which recovery has been seeming and partial only. The subsequent degenerative processes in the brain have led on the one hand to psychical states modifying character, and on the other hand to those pathological changes which lie at the bottom of the group of symptoms to which the name of Parkinson's disease is applied.



EPIDEMIC OF 1918-19

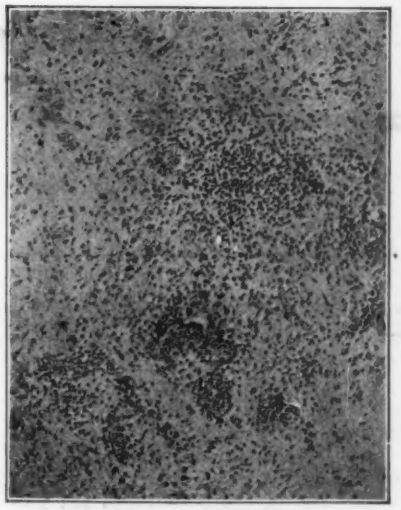
Epidemic encephalitis cases are far more numerous in winter than at others of the several seasons of the year



ANOTHER PHOTOMICROGRAPH

Cross-section of the brain, showing characteristic collection of lymphocytes about the small blood vessels

Our knowledge of epidemic diseases in general readily enables us to identify them with the diseases recorded in earlier medical or other writings. Their history is a long and sinister one. We can easily trace plague, cholera, influenza, smallpox into the remote past. With epidemic encephalitis the case is wholly different. We have not discovered in the written records of disease, descriptions with which it can be certainly identified. Certain kinds of nervous affections attend other epidemic diseases, as influenza, meningitis, and smallpox. But these affections differ in symptoms and in pathology from the disease which since 1918-1919 has circumnavigated the globe and come to be called epidemic encephalitis. No one can of course assert that it is new in the history of the world; it may indeed have a local habitat not now known, but which future exploration may reveal.



SECTION OF BRAIN

Characteristic abnormal collection of lymphocytes in small vessels and in the substance of the brain tissue

THE exciting cause of this apparently new sort of epidemic disease is being sought assiduously by bacteriologists all over the world. Already on two or three occasions, premature announcement of its discovery has been made. That ultimately it will be discovered may well be predicted. It is already known that the microbe—for one cannot doubt that the disease has a parasitic origin—does not belong to the classes of organisms detectable by the means at present available to bacteriologists. But as these means are being constantly refined and made more effective and as microbes unknown a decade or two ago are by them now easily distinguished, it requires no undue faith to express the belief that the time is not far distant when the source of this severe disease may be determined.

A curious complication of this study has been the confusion of the virus of cold sores with the virus of epidemic encephalitis. The confusion arose from the strange fact that the cold-sore virus produces encephalitis in rabbits. The first efforts to induce epidemic encephalitis in laboratory animals seemed to be successful. But a condition so inoffensive as cold sores in man, when transferred to animals, may give rise to severe and even fatal effects.

Why Fly Without Radio?

When Lost at Sea, a Crippled Plane Without Wireless Has as Much Chance as a Mouse Among Cats

By ORRIN E. DUNLAP, JR.

TRANSATLANTIC airplane flights seem to come in eight-year cycles and always in the spring, because weather conditions are more favorable at that time for long oversea trips through the air. The year 1919 stirred up the daring of birdmen. A flock of them migrated in May and June of that year to the Grand Banks of Newfoundland. Two successfully winged their way to the other side of the ocean, but the majority met with adversity in preliminary tests or dropped into the sea.

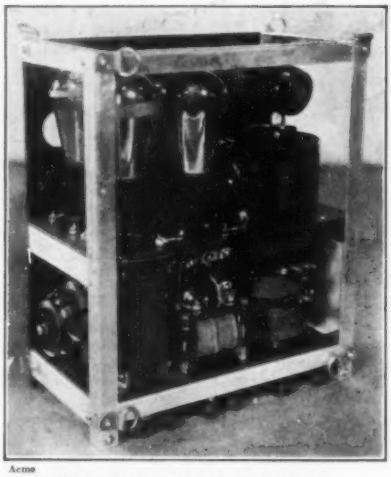
Eight years passed before another flock perched on flying fields in the United States and France ready to annihilate the distance between the Old and New Worlds when the weather man signaled that all was well in the air.

THE *American Legion*, piloted by Lieutenant-Commander Noel Davis and Lieutenant Stanton Wooster, was one of the first planes ready to leave for Paris in the spring of 1927. It carried the latest in radio equipment, including a short wave transmitter, the signals from which were heard with good intensity in Times Square, New York City, when the plane was cruising over Langley Field in Virginia. One morning it went up for a final test. It was heavily burdened. There was difficulty in rising. It fluttered like a duck shot in mid-air and plunged into a swamp. The two gallant fliers were killed.

The radio set which was designed to radiate the glory of aviation from the expanse over the Atlantic came to grief in a muddy pool, before it even had a chance to send out a plea for help. In fact radio was not needed in this emergency. Men saw the plane drop. They rushed to the scene of the accident. But, had the plane surrendered itself to the mercy of the Atlantic, radio's role might have been entirely different than it was in the Virginia mud.

Several weeks later a flash from Europe announced that the ace of aces, Captain Charles Nungesser, who had shot down 47 enemy planes during the World War, and Captain Francois Coli, had hopped off from Le Bourget flying field and were on their way to New York in the *White Bird*, with no radio on board. It had been discarded to save weight. The plane was last seen as it passed over Ireland headed out over the Atlantic, where, as one noted aviator remarked, "without radio they had as much chance when they dropped to the water as a mouse among cats."

It was on May 8 that Nungesser, Coli and an array of mechanics were up before daybreak. Some hundred blue-coated poilus in steel helmets and with bayonets fixed patrolled the field. Lightning flared. A downpour dampened Paris and vicinity, but not the spirits of the airmen. They were aware that the storm was local and that in the distance the sky was clear. The clouds disappeared. The day dawned rose and gray. The two men climbed into the cockpit to follow the sun into the west. Nungesser



Acme

AIRPLANE RADIO RECEIVER

This four-tube radio receiver was designed especially for use on one of the monoplanes of the Bellanca type

shouted, "Let's go!" The white plane taxied 1000 feet down the field and an escort of a dozen planes followed as far as the coast to make sure that the craft carrying the emblem of a coffin, skull and bones, got well underway with its heavy load. They watched it dash off through the early morning mist toward England and then returned to Paris to await news from America that the *White Bird* had triumphantly come to roost on Long Island. Forty hours passed; fifty, sixty, seventy! Nungesser was long overdue. Disappointment swept over France and the rest of the anxious world when reports from New York told that the plane had not been sighted and that lightning which gave it a send-off was thundering over Manhattan's skyscrapers at the hour when the plane was scheduled to arrive.

While searching parties were hunting for the *White Bird* in the North Atlantic, a youthful flier, Captain Charles Lindbergh, piloting a monoplane made a record flight across the continent, making only one stop at St. Louis enroute to Long Island, where he nestled his plane among the transoceanic aspirants gathered at Curtis Field. Twelve days later, on May 20, the 25-year old aviator climbed into the cockpit of his machine, which faced down the runway toward the east. The 200-horsepower engine roared. The blocks were pulled from beneath the wheels. The plane lumbered down the field with its 5200-pound load, the heaviest ever lifted by a 200-horsepower engine. Suddenly the wheels of the machine cleared the ground and Lindbergh was in the air with the silver nose of the monoplane *Spirit of St. Louis* pointed toward Newfoundland and the great-circle route to Europe. There was no radio on board. Perhaps the unconquerable youth left it behind because of the same psychology that prompted him to say that he was taking only five sandwiches and a bottle of water as meagre rations. "If I get to Paris I won't need any more, and if I don't get to Paris I won't need any more, either," said Lindbergh.

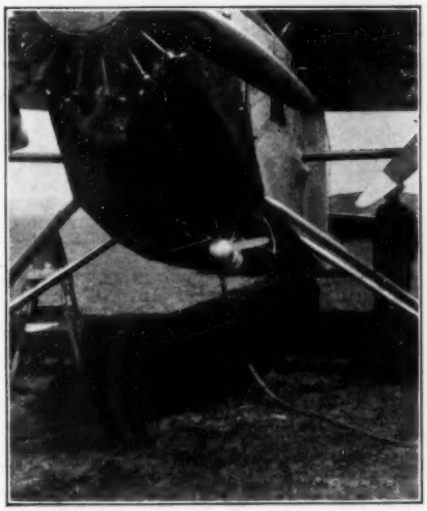
LUCKILY he did not need radio. Off above the trees of Long Island the silver wing-span dipped out of sight. It was 8 A.M. Throughout the day came reports from along his course that the craft was running true to schedule, and at 7:15 P.M. he headed out from St. John's, Newfoundland, over the open sea. The next morning ships sighted him off the Irish coast. Everyone who owned a radio set stayed close to the loudspeaker all afternoon and evening waiting for a flash that "Lindy" had landed. Six minutes after the wheels of the plane touched Le Bourget Flying Field outside of Paris, New York broadcasters had the report on the air, thus relieving 33½ hours of anxiety throughout the world.

Two weeks after Captain Lindbergh landed in France, a monoplane of Bellanca design, named *Columbia*, soared into the air at 6 o'clock on the morning of June 4, and left Long Island bound for Europe. It carried

Clarence D. Chamberlin as pilot and Charles Levine as passenger. Shortly after 3 o'clock the next afternoon the plane circled about the *S.S. Mauretania*, 340 miles from Land's End, England. Soon they were reported over Normandy and then over Germany, where the fuel ran low and forced a landing at Eisleben, about 110 miles southwest of Berlin, the plane having been in the air 42½ hours in flying 3905 miles. The tanks were quickly filled and the craft resumed its journey to Berlin. They did not travel far, however, before another forced landing was necessary and the plane came down in a marsh near Kottbus, 70 miles from the capital of Germany. In alighting, the propeller hit the ground, breaking a blade as the wheels settled in the marshy earth. Thus ended another transatlantic air voyage, the first of its kind from the United States to Germany. There was no radio on board.

COMMANDER RICHARD E. BYRD'S giant transatlantic Fokker, which made a forced landing in the English Channel after becoming lost in fog, was equipped with an automatic device to flash continuously the call letters WTW on the 690-meter wave, excepting at times when the radio was used for communication. Thus, if the call letters ceased, the receiving operators were aware that the man on the plane was going to transmit a message or that something had gone wrong. The constant stream of call letters was made possible by a little wind-driven turbine geared to a cam wheel, which caused an electric contact to make and break the transmitter's keying circuit in the sequence of code characters.

The total weight of the radio equipment was 115 pounds. Besides the automatic sending unit, it consisted of a transmitter employing two 50-watt tubes. A simple adjustment enabled the operator, Lieutenant G. O. Noville, to shift quickly from the working wave of 690 meters to the universal distress wave of 600 meters. The wavelengths were checked by a miniature wave-meter with indicator lights built into the main panel. The sending range was from 200 to 400 miles in daylight, and much further at night. The receiver was similar to a 4-tube broadcast outfit, excepting that the wavelength range was from 500 to 1500 meters. Special precautions were taken to minimize interference caused by vibration and motor ignition. The antenna was a Number 18 bare copper wire with a three-pound weight on the end. It was reeled out to about 450 feet below the fuselage. The metal framework of the plane acted as the counterpoise ground.



Herbert Photos

RADIO GENERATOR

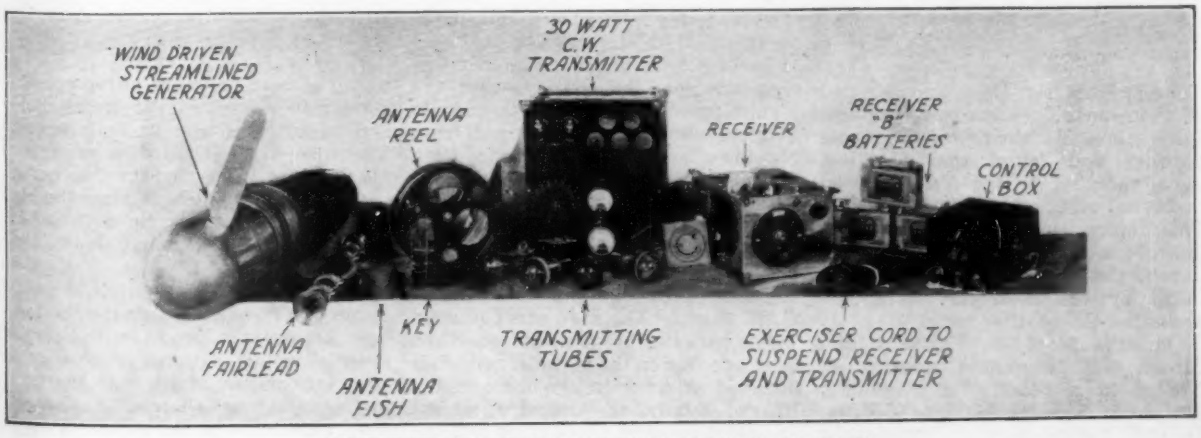
The single-blade propeller under the fuselage drives the generator which supplies the current for the transmitter and for charging the batteries

Power for the transmitter and to charge the storage battery, was supplied by a wind-driven electric generator mounted underneath the plane about five feet behind one of the propellers. The single blade fan of the generator was regulated to a speed of 4000 revolutions a minute, regardless of the forward speed of the machine. This was effected by means of a centrifugal governor. The fan was very carefully balanced and delivered about two-thirds of a horsepower to the generator. All switching was done by a combined gang switch totally enclosed in a flameproof box, with only the handle projecting in order to eliminate any possibility of igniting gasoline fumes.

AN emergency set was carried in case the aviators were forced to abandon the plane and take to the rubber life-rafts. This transmitter weighed only 13 pounds and was so constructed that it could be operated when entirely submerged in water, a successful test having been made by dropping the set into a barrel of water. This set was designed to operate with dry batteries for from five to 15 hours. A kite was carried to hold the aerial wire aloft in case of a forced landing, giving the outfit a range of about 30 miles.

"If I had to choose between a radio transmitter or receiver as equipment for a plane in which I might plan to cross the ocean, I would most certainly select the transmitter, and a good strong one at that," said Dr. A. N. Goldsmith, Broadcast Engineer. "In my mind, being at sea in a disabled airplane would call unmistakably for apparatus that would tell some one about it and do it lustily. A good transmitter would be of much more value than a receiver in transoceanic airplane navigation, for the same reason that a man who has a good voice to rely upon in an emergency stands a better chance of attracting aid than a man who is dumb."

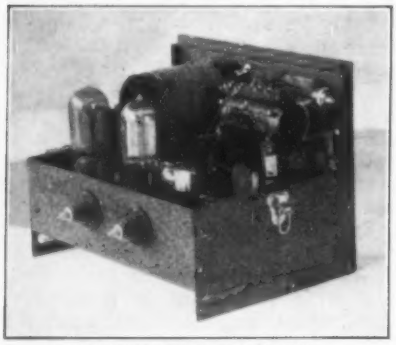
In this connection attention is called to the flight of the naval seaplane *PN-9* in its attempt to cross from California to Hawaii in September, 1925. The seaplane was equipped with a radio receiver but no transmitter. The craft was crippled en-



PARTS USED FOR TYPICAL AIRCRAFT RADIO INSTALLATION

route and was forced down on the surface of the Pacific, where it drifted for more than a week while airships and vessels searched off Hawaii. The crew listened to radio messages exchanged by those engaged in the hunt but could not answer or send a call that would give a clue to a radio direction finder. They actually received the dispatch that proclaimed the abandonment of the search. Finally, a ship sighted the plane and rescued the airmen, who were under the command of the naval flier, the late John Rodgers.

THE *NC-4* naval seaplane, the first airplane to cross the ocean in May, 1919, proved the value of radio on a transatlantic flight. It was not many hours after the *NC-4* and her sister ships *NC-1* and *NC-3* left Rockaway, that the importance of radio equipment was realized by the men on the planes and those on shore. The *NC-4* developed engine trouble soon after sailing over Boston and was forced to descend at sea off the New England coast. Operators on land noticed that the *NC-4* reported difficulties developing in the oiling system. Soon the plane was silent. Messages were sent to the sister ships asking if they could see the *NC-4*. They said that she was not in sight. The naval operators at Otter Cliffs, Bar Harbor, Maine, had been listening to the



SMASHED IN A SWAMP

This is a rear view of the short-wave transmitter designed for use on the ill-fated American Legion, *in which Commander Davis and Lieutenant Wooster lost their lives in a Virginia swamp*

pioneers from the time they hopped off about noon. It was now 4 o'clock. They checked their radio-compass bearings and found that the last signal radiated by the *NC-4* showed that it was off Chatham, Massachusetts. This information was broadcast to destroyers. A search began along the line of the bearing. The *NC-4* was found by the destroyer *McDermott* at sunrise the next morning.

On June 14, 1919, Captain John Alcock and Lieutenant Arthur W. Brown, in a Vickers-Vimy bomber, flew from Newfoundland to Clifden, Ireland, a distance of 1980 miles, in

Herbert Photos

THE "AMERICA'S" WIRELESS

The transmitter is shown above and the receiver below. Both sets are suspended on rubber to prevent mechanical vibration from interfering with the operation. The operator wears a helmet with the earphones built into it

16 hours and 20 minutes. This was the first non-stop transatlantic airplane flight. The Vickers-Vimy bomber was designed with a radio direction-finder as part of its equipment. The loop antenna was built in the wings and the receiver acted as a radio compass. The world awaited anxiously for news from the airmen, but the ether was silent. The navigator was taking bearings on the waves sent out by the powerful transmitter on the Irish coast. So true was the guiding influence of radio that the plane flew directly over the Clifden towers.

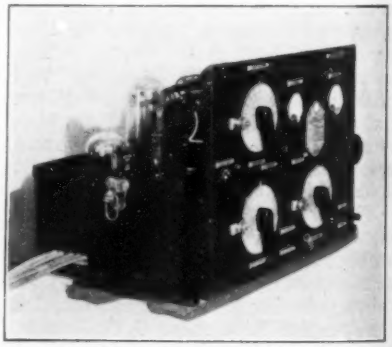
A MONTH before Alcock and Brown hopped off, Harry Hawker, an Englishman, and Lieutenant Commander Mackenzie Grieve, as navigator, left St. John's for Ireland in a Sopwith biplane. His original plans called for radio equipment, but he discarded it to lighten the craft at the last minute. Nothing was heard of Hawker and Grieve for more than a week. They were given up for lost. Memorial services were held in London. Several days later it was reported from the Orkneys that the Danish steamer *Mary* had rescued the aviators about 1050 miles out from Newfoundland, about 850 miles from Ireland. The *Mary* was not equipped with wireless.

Late in June, 1919, the British dirigible *R-34* flew from Scotland to Long Island and then returned safely to Pulham, England, piloted by Major G. H. Scott. The *R-34* was equipped with a vacuum-tube transmitter. When off Cape Race, the signals were first detected in America. When over the Bay of Fundy, the operator flashed an urgent message announcing that the fuel supply was running low and that a forced landing might be necessary. This message was intercepted at the naval station at Otter Cliffs. A "sub chaser" was loaded with tanks of fuel and sent out about 100 miles from Bar Harbor to meet and aid the dirigible. As she sailed overhead the wireless man signaled that they could reach Chatham Air Station and possibly Mineola Flying Field, which they succeeded in doing.

IN 1924, the United States Army Air Service 'round-the-world planes crossed the Atlantic by way of Greenland. They did not carry radio. It was also in 1924 that the Zeppelin *ZR-3*, later renamed the *Los Angeles*, flew across the sea from Friedrichshaven, Germany, to Lakehurst, New Jersey.

"Picture yourself," said Leo Freund, operator on board the dirigible, "in an airship for three days sailing over the ocean, and the navigator is unable to make use of his sextant to determine the position, not being able to see the sun, moon or stars. It would therefore be dangerous to make a trip of this length without radio apparatus. With radio you can determine the exact point of the ocean above which you are sailing by establishing communication with a sending station either on land or on a ship at sea."

Commander Richard E. Byrd car-



AN AIRCRAFT TRANSMITTER

A front view of the set illustrated at the left. It operated on a 45-meter wave, and its signals were clearly heard in New York when the plane was cruising over Langley Field, Virginia

ried a short-wave transmitter operating on 40 meters to the North Pole and back to his base at Spitzbergen. The men on board the dirigible *Norge* found radio to be a "friend in need is a friend indeed," when the big ship was lost in the Arctic wastes after passing over the North Pole in the spring of 1926.

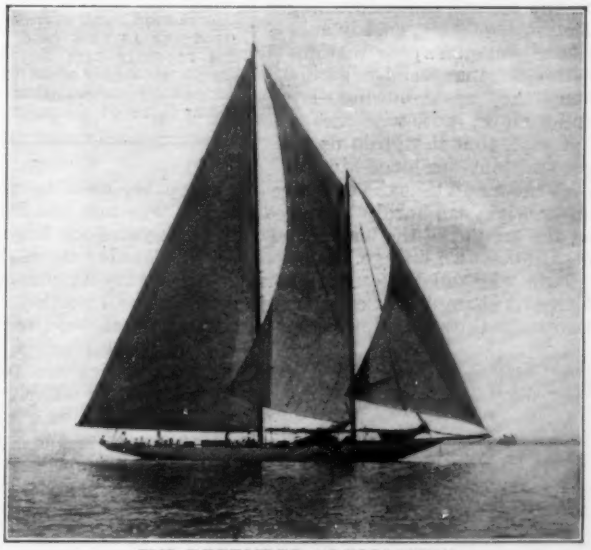
Experts call the attention of aviators to the fact that amateur operators talk around the world with simple short-wave installations, which if carried in compact form on board a plane, could reach shore with messages from any point in the Atlantic.

TWO VIEWS OF THE "KATOURA"

The hollow mast, 152 feet long, was the largest ever put in a yacht. Note in left-hand view, taken off starboard bow, the three sets of spreaders. The topmast section, 13 feet long, could not be held in its place; it was later removed

SCHOONER "VANITIE"

Built as a sloop for America's cup defense. Under schooner rig she is faster than cup defender the Resolute



CUP DEFENDER "RESOLUTE"

As a sloop she successfully defended America's cup against Thomas Lipton's challenger, the cutter Shamrock IV

Sloop Versus Schooner

The cup defenders, for the past 40 years, have been "single-stickers." Last year the cup yachts *Resolute* and *Vanitie* came out under schooner rig, with which *Vanitie* proved superior. Both boats embodied the new staysail rig in place of the old gaff-headed sail between the masts. This year, that enthusiastic yachtsman, Robert E. Tod, has put in commission a new sloop of the same water-line length as the *Vanitie* and *Resolute* (75 feet), the rig being similar to that of the famous little six-meter boats. There is no bowsprit. The towering mainsail is jibheaded, and the end of the main boom is inboard, or just above the taffrail. The single mast, originally 152 feet long, has been cut down 13 feet, and now measures 126 feet from truck to deck. By the end of the season it will be possible to determine whether this sloop, with a total area of 6475 feet, can beat *Vanitie*, which carries 8018 square feet. Under schooner rig, *Vanitie* is too good for *Resolute*, especially in windward work.

Dawn-Man or Ape?

Was Our Ancestor a Dawn-Man, or Did We Descend Directly From an Anthropoid Ape of an Ancient Geologic Epoch?

By WILLIAM K. GREGORY
Professor of Vertebrate Paleontology, Columbia University

PROFESSOR HENRY FAIRFIELD OSBORN, one of the most famous scientists in the world, not long ago published an article in the Sunday edition of the *New York Times* in which he maintained that the idea that man has been derived from an ape was a myth due to our ignorance of the real course of human evolution, and that humanity would be thankful to anthropologic science for having at last removed this bar sinister from man's pedigree.

In addressing the Bicentenary meeting of the American Philosophical Society at Philadelphia on April 30, 1927, Professor Osborn reviewed the recent discoveries in the field of prehistoric anthropology which had led him to these views. I, on the other hand, addressing the same meeting, said in substance that man's poor relations —the chimpanzee, the gorilla and the orang-outang—are still with us, mute witnesses of the past, that it will do us no good to deny our blood kinship with them and that the evidence of our lowly origin can hardly be waved aside on the ground of the length and aloofness of our own lineage.

Now why did Professor Osborn, the foremost champion of evolution in our time, take the stand that he has taken? And why did I, owing so much to Professor Osborn as my honored leader and friend for nearly thirty years past, feel it necessary to differ with him so publicly? And in brief, what is it all about?

Professor Osborn's side of the story may be summed up as follows: Recent discoveries prove that the human race is far older than it was formerly thought to be, even by scientists themselves.

A Friendly Controversy

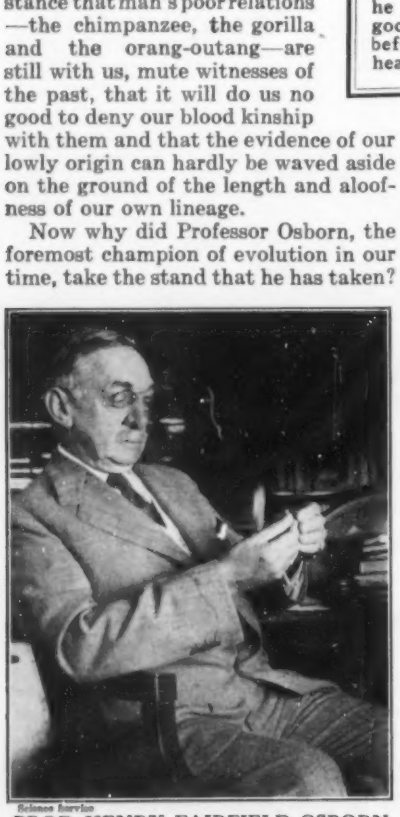
When Prof. Henry Fairfield Osborn, noted paleontologist and President of the American Museum of Natural History, recently stated that "no existing form of anthropoid ape is even remotely related to the stock which gave rise to man," he spoke with sincerity, and certainly not, like many of the poorly instructed popular writers who deny man's ape ancestry, without his own scientific reasons, although much may be said against these reasons.

Dr. Osborn's espousal of the man-from-an-independent-source theory has renewed a nearly abandoned controversy in science—a friendly controversy in this case, as the editor noted when he recently saw Dr. Osborn and Dr. Gregory good naturedly debating their respective beliefs before a famous gathering of scientists. We shall hear more of this controversy. —*The Editor.*

For tens and hundreds of thousands of years in Europe great ice sheets crept downward from the north and from the highlands out on to the plains, until all northern Europe and North America were covered with vast continental glaciers, as Greenland and Antarctica are today. During these periods of bitterly cold climate, Europe was the home of such cold-defying animals as the woolly mammoth, the woolly rhinoceros and the musk-ox. During other tens and hundreds of thousands of years the climate gradually softened, the ice sheets retreated to the north or to their upland centers and tropical mammals such as hippopotami invaded Europe.

In all there were four such major advances and retreats of the ice in Europe during the Pleistocene epoch and the latest provisional estimates of geologists place the beginnings of the Pleistocene as not less than one million years ago.

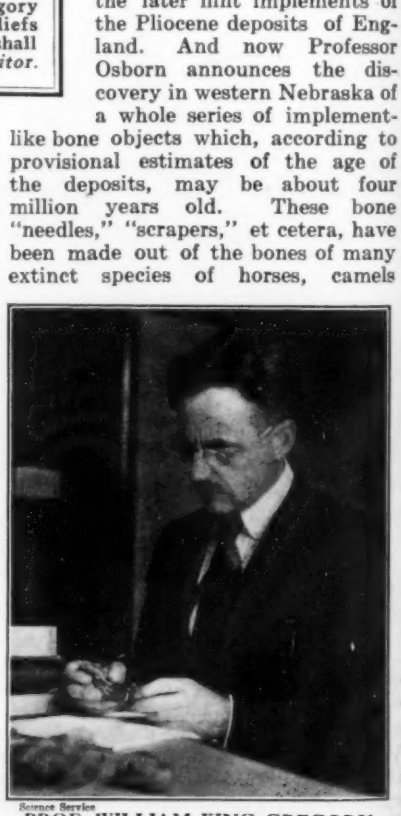
But far down in the Pleistocene age, during the First Interglacial interval, the Heidelberg man died and left his jaw, which was found under seventy-six feet of stratified glacial sands. And far below the level of the Heidelberg man, in the pre-Pleistocene deposits of the southeast coast of England, is a series of strata containing flint objects apparently fashioned into crude implements by human hands. Professor Osborn has been the great champion of their discoverer, Reid Moir, the patient investigator of Ipswich, England, who has endured the neglect and opposition of other scientists. These sceptics have denied that Reid Moir's "implements" are of human origin and have attributed their resemblance to true implements to the chance knocking about of flint nodules by the action of water. But the Abbé Breuil and other famous archeologists now admit that some at least of Reid Moir's flints are of human manufacture. More than one million years is Professor Osborn's estimate of the age of even the later flint implements of the Pliocene deposits of England. And now Professor Osborn announces the discovery in western Nebraska of a whole series of implement-like bone objects which, according to provisional estimates of the age of the deposits, may be about four million years old. These bone "needles," "scrapers," et cetera, have been made out of the bones of many extinct species of horses, camels



Science Service

PROF. HENRY FAIRFIELD OSBORN

He holds that man did not descend from an ape, but from some undiscovered stem common to man and apes



Science Service

PROF. WILLIAM KING GREGORY

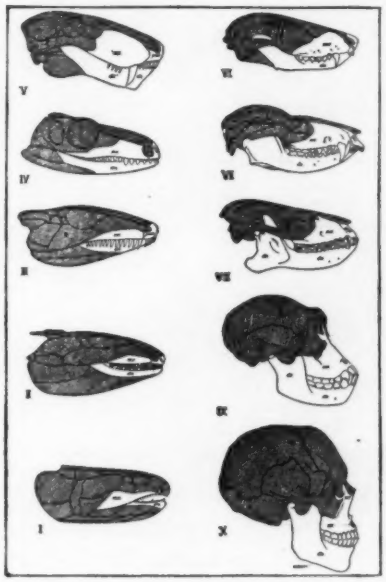
He believes that man descended from some early ape which was not unlike the modern apes in general appearance

and other mammals, whose shattered bones are heaped together in wild confusion. Moreover, close duplicates of many of these bone objects have been found in the refuse heaps of ancient Indian settlements of the southwest, and others in the ancient shell heaps of Maine.

Professor Osborn states that these are either the work of men several millions of years ago or astonishing freaks of nature. If, argues Professor Osborn, several million years ago men were already men, capable of devising and fashioning more than eighteen different types of bone implements, what becomes of the "myth" of man's origin from the ape?

Professor Osborn does not even rest his case on the validity of the Pliocene age of men in Nebraska but proceeds to show that a close study of the skeleton of the extinct Neanderthal man proves that for thousands of generations the ancestors of this now extinct race had been upright-walking men with hands and feet and all other parts of the skeleton essentially human rather than ape-like in character. Moreover, he points out that the human hand has a well-developed thumb, while the thumb of all apes is reduced, the hand tending to become hook-like; that in the human foot the great toe is held nearly parallel to the other toes, while in the apes it is widely set off like a thumb; that when men climb trees they do so in an awkward human way quite different from the highly competent manner of apes.

Finally, Professor Osborn holds that the scientific name *"Pithecanthropus"* is a misnomer, that the so-called *Pithecanthropus* of Trinil, Java, was not an ape-man as the Greek word implies but a true "pro-man" or "dawn-man," walking erect and capable of human speech and human thought. This is deduced from a comparison of the



EVOLUTION—FISH TO MAN

The same two tooth-bearing bones shown in white in each drawing may be traced from an ancient fish of the Devonian Period (lower left-hand drawing) through fossil amphibians (drawing II), into the line of reptilian forms (III-VI) that gave rise to the lower mammals (VII, VIII) and finally culminated in the chimpanzee stage (IX) and man (X)

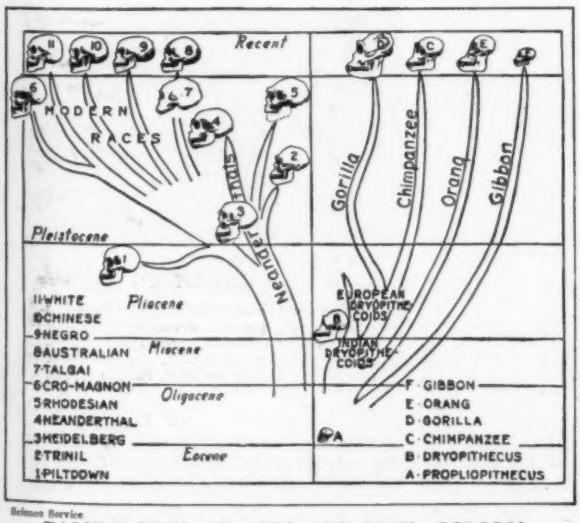
"brain cast" or cast of the interior of the skull of the famous Javan fossil with those of men and apes. For Professor Frederick Tilney finds in the convoluted surfaces of this brain, areas associated with thought, imagination, reason and speech.

And there are other lines of evidence also which Professor Osborn cites in support of his side of the argument. Again and again paleontologists have traced back the lineage of horses and elephants, pigs, cows, bears, cats, dogs and many extinct animals with Greek names, through the unbelievably long ages of the Tertiary period or Age of Mammals. But with hardly any exceptions, the earliest known representatives of these families are still recognizably different from each other, even in Eocene, or early Tertiary, times. As with the other mammals so with man, argues Professor Osborn, and most paleontologists will agree with him in expecting to find the direct ancestors of man already distinct from the anthropoid apes as far back at least as the Lower Oligocene epoch or second division of the Age of Mammals, some forty millions of years ago according to the late Professor Barrell's estimates of geologic time.

In the face of this seemingly crushing array of evidence assembled by a paleontologist of world-wide renown, can anything still be said in favor of Darwin's view that man is an offshoot from the anthropoid stock?

My reply to Professor Osborn's argument is in part as follows: Whether Reid Moir's Pliocene flints and the Nebraska bone "implements" are of human origin or not, there is other and ample evidence for inferring that man in the Pliocene epoch was already quite distinct from all other mammals.

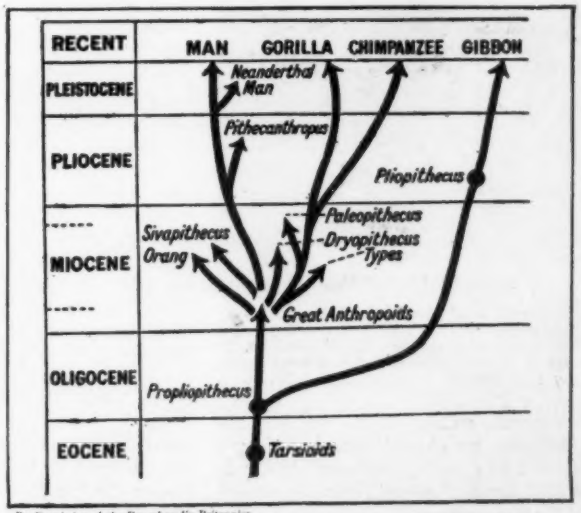
Nor do I deny that all the known fossil races of men were definitely within the limits of the human family in the main characters of brain and skeleton. Since 1916 I have written frequently that the branching off of man from a lower primate stock may not, in the present state of our evidence, be looked for later than the Middle Miocene epoch, which according to Barrell's estimates lay some ten millions of years earlier than the Middle Pliocene. Therefore the fact, *if it is a fact*, that the little-known men of the Middle Pliocene had already attained a human grade of organization, may mean only



Science Service

FAMILY TREE OF APES AND MAN—OSBORN

Oligocene times, in which Prof. Osborn believes man had his roots, ended 19,000,000 years ago, according to recent estimates based on the rate of radioactive change in the rocks



By Permission of the Encyclopedia Britannica

THE FAMILY TREE ACCORDING TO GREGORY

Miocene times, in which Sir Arthur Keith and Dr. Gregory believe man diverged from the ape branch, ended 7,000,000 years ago. Lower four epochs constitute "Tertiary period"

that the transitional stages between ape and man must be sought in an earlier geologic epoch.

But why assume that there were such transitional stages? Why not admit that man and ape always were different, no matter how far back we may go in geologic time? Chiefly because the sciences of comparative anatomy, of comparative physiology, et cetera, offer their silent testimony to the blood kinship, in a very real sense, of man and ape.

This evidence is scattered in a thousand technical papers; it can never be appreciated fully by the public, and has been repeatedly lost sight of even by paleontologists. No more convincing summary of this evidence has ever come to my notice than that by Sir Arthur Keith in his article on "Man, Evolution of," in the thirteenth edition of the Encyclopaedia Britannica. Let the reader who doubts the blood kinship of man to the anthropoid ape read that article with care and attempt to reconcile the facts cited there with the view that man and ape merely "parallel" each other in certain features.

If we study the patterns of the skull structure of representative vertebrates from the remote Devonian period to the Recent, and from fish to man (page 231, top) we see at once that the chimpanzee comes between the oldest fossil primates and man, and that in respect to many skull characters, man has advanced far beyond the chimpanzee but in the same direction as the latter has advanced beyond its predecessors. *In other words, even if we did not have the chimpanzee we should have to infer its existence as a sort of half-way station in the long road of ascent from the primitive Eocene primates.* Darwin's theory that man is a derivative from the anthropoid ape stock, although not from any existing type of ape, accounts for hundreds of such peculiar resemblances between man and ape. And what other scientific hypothesis can do this?

Courtesy the Illustrated London News

AUSTRALOPITHECUS

Restoration of the head of an extinct "man-ape" whose well preserved fossil skull was discovered at Taungs, South Africa. Sketch by A. Forestier, by direction of Prof. G. Elliot Smith

After Deniker

GORILLA FOETUS

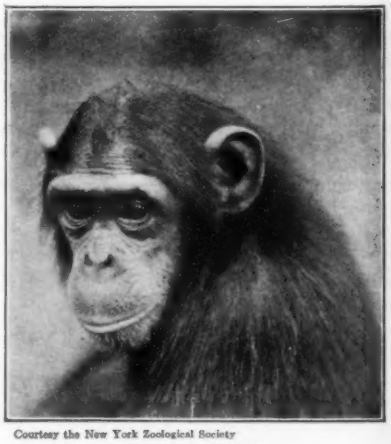
A systematic study of this picture will provide some interesting comparisons between ape and man. Note the feet

Professor Osborn in his latest article seems more inclined to recognize the features of resemblance between man and ape and to account for them on the theory that man and ape have inherited them independently from a neutral primate stock, perhaps of Lower Oligocene or Eocene age. But with this admission on record, the only outstanding differences of interpretation between Professor Osborn and myself are: (I) the age of the origin of the human family from the inferred ancestral group, and (II) the leading anatomical characters of the "neutral" or common ancestral stock which included both "dawn-men" and apes.

(I) As to the age of the separation of man and ape from the common stock, the chief reason Professor Osborn has for placing this date as far back as the Lower Oligocene or Eocene is that many other modern families, such as those of the horses and the tapirs, were distinct from each other as far back even as the Lower Eocene. *But as yet no one has cited evidence tending to prove that the rate of drifting apart between the families of men and of the anthropoid apes has been the same as it is known to have been between the families of the horses and tapirs.* On the contrary, it is a fact that the variability or measure of variableness in respect to the patterns of the molar teeth is far less in the families of horses and tapirs than it is in the families of men and of anthropoids. Just as domestic animals are highly variable or unstable and subject to evolutionary changes, so too, the evidence shows that the anthropoid apes and man are highly unstable and subject to evolutionary change. The millions of years and tens of thousands of generations between the "almost human" apes of the Miocene epoch and the primitive men of later Pliocene times would therefore appear to be a sufficiently long time for Nature to transform a primitive anthropoid ape into a primitive man, especially under the severe stress of the change from forest-living to life in the open. No direct evidence has ever been brought forward to the contrary and no one has shown why chimpanzee, gorilla and man should resemble each other in so many ways, if their ancestors parted company as long ago as the ancestral horses did from the ancestral tapirs.

(II) Admitting as Professor Osborn now does, that men and the existing family of apes arose independently from a "neutral" group ancestral to both, the question arises, what were the anatomical characters of *that* ancestral group? To this question Professor Osborn answers that the primitive dawn-men were ground-living primates, more resembling men than apes in essential features; while I adhere to the older view that the dawn-man stock were erect-walking, tailless descendants of a tree-living stock, with divergent great toes, low brows and poorly developed thumbs.

For the final settling of this question the greatest need is not only more facts but more sustained and intensive consideration of the thousands of facts already on record. In conclusion, I hold that to make inferences concerning *the rate of evolution of man* from the known rates for widely different mammals is unwarranted; that the man-anthropoid group has been a remarkably plastic group, and that the evolution of man was greatly accelerated.



Courtesy the New York Zoological Society

CHIMPANZEE

Of the four living anthropoid apes—the chimpanzee, gorilla, orang and gibbon —the chimpanzee is most like man in his psychology; however, the gorilla is somewhat closer to man in his brain

CATCHING A COBRA

At the laboratory where snake venom is collected for the purpose of making a serum for the treatment of snake bites, the captive snake which has been selected for the extraction process is released from its cage, and immediately recaptured by hand. This is accomplished as shown at the left. The snake catcher at once places a heavy stick just in back of the cobra's head, and at the same time places one of his feet on the snake's tail. With the reptile thus held securely, the captor can grasp it just to the rear of the head, with one hand, and thus hold the snake without fear of being bitten. Because of the fact that the snake's tail is secured, it is impossible for the reptile to writh about and possibly cause its captor to release it, with probable disastrous results. These snake-handlers, however, are experts in their work, and can carry on without fear of personal harm from the reptiles

Central Press

EXTRACTING THE POISON

The cobra's fangs are held over a glass having a rubber covering, and the venom is squeezed from the glands

FEEDING A COBRA

The reptile is held at full length, with tail held down, and milk is fed to it through a glass funnel as shown

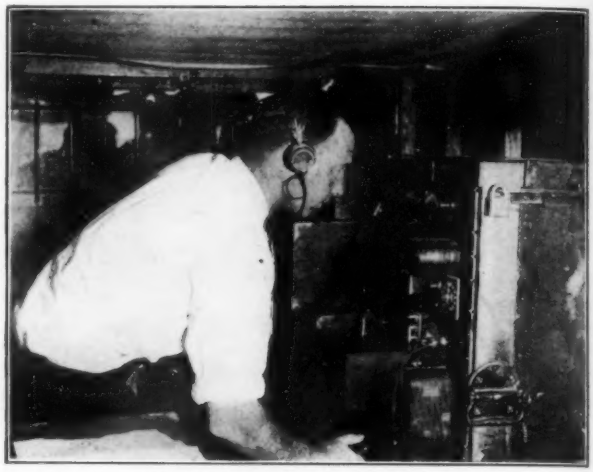
Extracting Snake Venom For Use in Serums

At the government laboratories at Parel, Bombay, India, a section is devoted to the care of snakes, especially cobras, whose venom is to be collected and employed for making serum. This serum is to be employed for treating victims of snake-bite. The three photographs which we reproduce above were taken at these laboratories, and serve to show the care which is employed in handling and feeding the dangerous reptiles. After the venom has been extracted from the glands of the snake by manipulation performed in the manner shown, the snake is fed on milk and returned to its cage. Here it recuperates, and a further supply of the poison accumulates. The extracted venom is used for injection into horses. This is done in gradually increasing doses, and finally a serum, which is an excellent antidote for snake-bite, can be obtained from the horse's blood. This serum is obtained by drawing several pints of blood from the horse and carefully separating the serum from the blood corpuscles. The material is then passed through a process whereby all bacteria are excluded. Such serum is now in wide use for the treatment of snake-bite. The same process is employed for making serum from rattlesnake venom.

All photographs courtesy Fox-Case Corporation

PORTABLE RECORDER ON LOCATION

The truck carries the equipment for photography and sound recording to the spot where a "news reel" is to be made



INTERIOR OF THE TRUCK

The operator is working the gain control on the vacuum-tube amplifier which supplies current for voice recording

Sounds Recorded On "Movie" Film

New Process Opens Wide Field for the Production of Satisfactory "Talking Motion Pictures"

By A. P. PECK

IN the June issue of this magazine, the writer described what was at the time the only "talking motion-picture" process that was in actual production, and promised details of other systems. Since the writing of the article mentioned, another method, which has been in the laboratory stage for several years, has been perfected and placed on a basis where theaters can be equipped with the necessary reproducing apparatus and can be supplied with films at regular intervals.

This latest system has been assigned the name of "Movietone" and is being fostered by the Fox Film Corporation and the Case Laboratories. The later concern has been active for many years in the field of developing photo-electric cells and kindred apparatus. As in the case of Vitaphone, the method heretofore described, the sound amplifying and reproducing instruments are supplied by the Western Electric Company.

The Fox-Case Corporation, as the producing concern is known, has equipped an elaborate studio for the actual production work. There are two rooms or studio stages in which production can go on either separately or simultaneously as necessary. Both studios are large in size, to allow for elaborate settings or large orchestral accompaniment; both have the usual equipment of lights used in motion-picture production as well as the special apparatus required by the sound-recording process.

The walls of these rooms are absolutely sound proof, so that it is never possible for outside noises to penetrate either room while a picture is being taken. In order to insure this complete isolation, each of the studios is wholly enclosed with a double wall. These walls are slightly over one foot in thickness, including an interior air space of six inches. Either side of this air space are three-inch walls of gypsum blocks and to the outside of each of these layers is an additional thickness of a material of cellular texture. On the inside of the studio walls this material is covered with heavy draperies of a sound-absorbing nature. Other similar draperies are hung about the studios. By this means, perfect acoustic conditions have been obtained.

The air in these rooms is changed every three minutes, purified by a washing process, heated in the winter, refrigerated in the summer, so that a constant temperature is always maintained.

The production of a Movietone picture does not greatly differ from the ordinary motion-picture production of a similar subject. The settings are constructed and lighted in the same way. A rehearsal is held before the actual picture-taking is made, such as is often done in ordinary picture-making. While the action in a "talking-movie" rehearsal is being checked up by the director sitting behind the camera, in another room the vocal director checks up the tonal quality through the simple method of having a loudspeaker connected with the microphone in the studio. By this means, defects in amplification and modulation can be detected and corrected at once. Also, the placement of the microphone can be determined accurately before actual recording is started.

Aside from the fact that the camera is motor driven and is connected by wire with the telephonic apparatus, there is little difference between the recording of picture and voice by a Movietone camera and the ordinary picture recording in a motion-picture studio.

In the new process, standard motion-

Now the "Talking News-Reel"

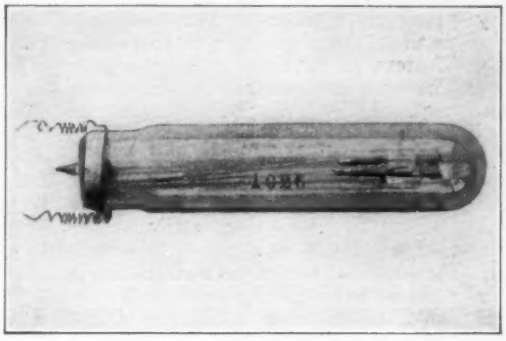
For years we have been entertained by the various happenings of the day as presented by motion pictures, and have used only our eyes in doing so. Now we can both watch and hear the prominent personages of the day, the results of great disasters, the taking-off of an airplane for another epoch-making flight, and the like. The "talking movie" has invaded the field of the news-reel, and this has been made possible by the system described on these pages. The equipment necessary has been made so compact that it can all be carried on a motor truck and so can be rapidly transported to the site of an important happening. —*The Editor.*

picture film is employed. On this film is recorded both the moving picture and its sound accompaniment, whether the latter be vocal, instrumental or incidental. In its basic elements the process is simplicity itself.

It consists, briefly, in photographing variations of light intensity on moving-picture film. This is accomplished by collecting the sounds to be recorded through the use of a microphone, which has the property of changing sound variations into electrical variations. These electrical variations are amplified, and in turn vary the intensity of the recording light.

THIS light is illustrated in these columns. It contains a filament and plate, similar to the two-element vacuum tubes that were used to some extent, many years ago, in radio reception. The filament is coated with an alkaline earth oxide, from the initials of which the name of the light, Aeo, is obtained. The filament and plate are sealed in a small quartz tube, from which the air has been removed and helium gas has been substituted. This tube is connected in the output circuit of a transformer, the input of which is connected to a vacuum-tube amplifier. This latter unit is placed in the circuit so that it steps up the impulses from the microphone, and so supplies these variations of current to the recording tube in a strengthened form.

The filament of the tube is connected to a low-voltage battery, while a high-voltage battery is placed in the plate circuit. When the apparatus is in use, the filament is lighted by its battery, and the plate current is turned on. The filament battery is then disconnected and the flow of current within the tube causes the action to be carried on. The glow emanating from the tube is of high actinic value, and the fluctuations of its intensity, corresponding with the sound variations as they affect the microphone, are rapid and accurate. Because of this, the variations of light as they are recorded on the sensitive film are faithful in their gradations as compared with the sound fluctuations delivered to it electrically.



SOURCE OF THE RECORDING BEAM

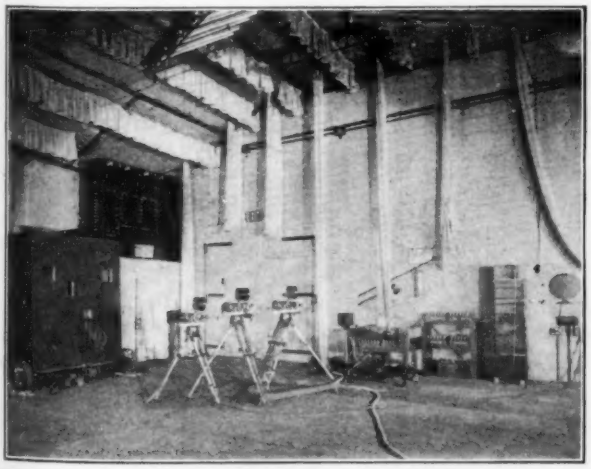
From this special vacuum tube comes the light which records on the film the variations which are later to be transformed to sound waves

The recording light is inserted in the back of the camera in such a manner that the variations in light intensity fall directly upon a narrow edge of the negative film on which the motion picture is also simultaneously being recorded.

The width and length of the tiny beam of light that falls on the negative are rigidly held to the proper limits by a novel means. Situated between the Aeo bulb and the sensitive film is a quartz plate on one surface of which has been deposited a silver film. A slit .00008 inch wide by .01 inch long is cut through this layer of silver. This slit governs the size of the fluctuating beam as it reaches the photographic film, and prevents the light from affecting any more of the film than just that part assigned to the recording of the sound. The use of this system was decided upon after repeated attempts to employ slotted metal sheets all resulted in poor recording and reproduction, due to imperfections in the cutting of the metal, dust collecting in the slot, and the like.

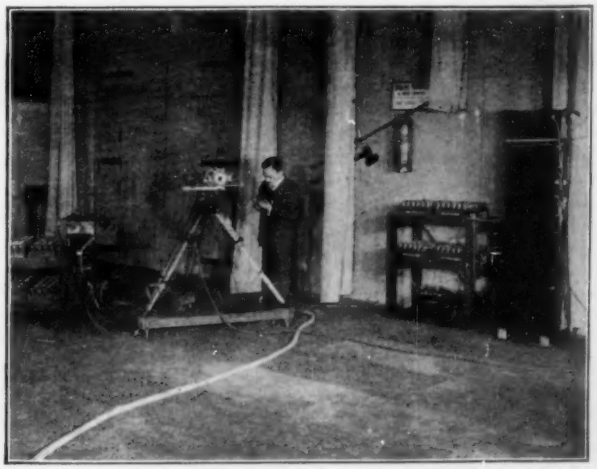
The entire action of recording is graphically depicted in a simplified form on page 236. In this drawing we show the source of the sound at 1. The sound waves, regardless of what the source may be, are set up in the air, and are indicated by 2. These strike the microphone and vibrate the diaphragm. Thereupon, electrical fluctuations, corresponding to the sound waves, are sent along the wires 3 to the vacuum-tube amplifier. Here they are built up and sent along the wires 4 to the Aeo light 5, previously described. After passing through the slit in the silvered surface of the quartz plate, indicated by C at 6, the fluctuating rays of the light strike the sensitive film A. When the film has been developed and printed in the usual manner, the finished positive has the appearance shown at 7.

THE process of reproducing the sound and pictures in this new system is practically the reverse of the recording system. The standard film, containing both picture and sound in a photographic record, is run through a standard moving-picture projection machine, to which has been attached a sound-reproducing unit. This includes a light, which is focused by a lens system through a narrow slit onto the sound record of the film. This slit is the same as the one previously described. As the sound record on the film passes by the slit, it



IN THE "TALKING MOVIE" STUDIO

Three of the special cameras are shown. The sound-proof booth to the left is used when the conditions require quiet



PART OF THE RECORDING EQUIPMENT

To the reader's right is shown the vacuum-tube amplifier panel and the storage batteries which supply the current

interrupts the constant light shining through it, and sets up light variations corresponding directly to those photographed. These changes in light variation then fall on a photo-electric cell, which changes the light variations back to electrical variations. These electrical variations are then amplified and carried by wire from the projection booth to the screen where they are reproduced with great fidelity through loudspeakers.

THE particular photo-electric cell used here is worthy of further mention. It is essentially an extremely sensitive relay which is actuated to varying degrees by the fluctuating beam of light as the rays pass through the sound record on the film. The cell consists of an evacuated glass bulb, the inner surface of which is partially coated with a film of barium. One electrical connection is made to this film. In the center of the bulb is a filament which is burned only when the cell is in the process of being made. The other connection is made to one of the terminals of this filament which is used only as an electrode.

When the cell is finished, and connected to the in-put of a vacuum-tube amplifier, a beam of light passing through the glass wall and striking both the filament and the barium film will form a conducting path, the resistance of which will depend on the intensity of the light beam. It will thus be seen that, as the light beam, fluctuating in accord with the sound currents, enters the photo-electric cell, a current will be set up in the circuit of the cell, which current will vibrate in synchronism with the intensity of the light, and therefore in synchronism with the original sound wave. This current, when used to actuate a reproducer, will then set up other sound waves which will be exact reproductions of the originals.

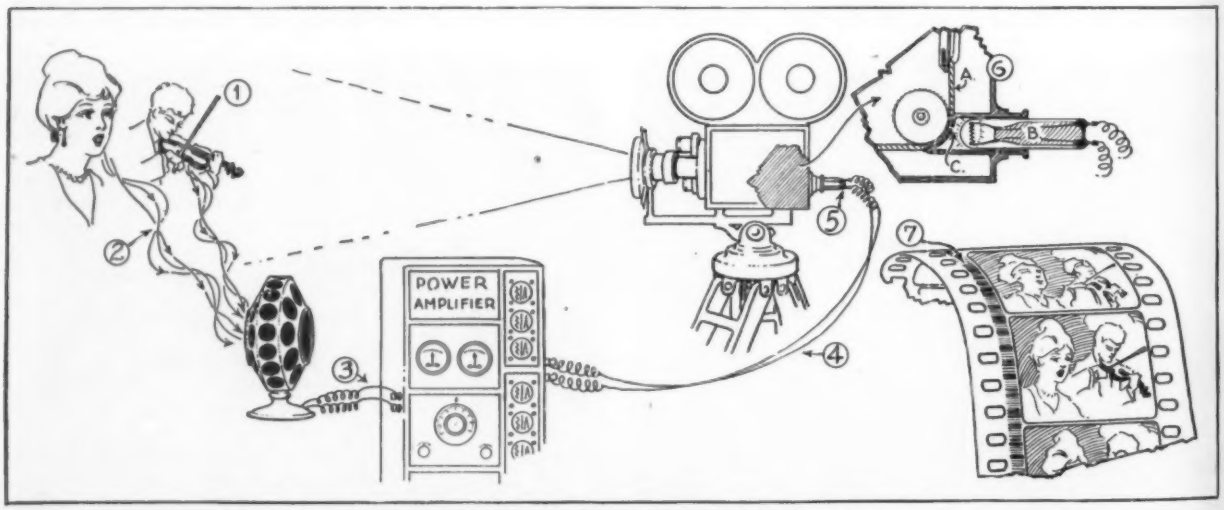
In the new process, aside from its own various particular patents, such as for example, the Aeo tube, certain telephonic apparatus is necessary. This embraces the use of such devices as amplifiers, microphones, and loudspeakers, both in recording and reproducing. Wherever telephonic apparatus is employed the devices of the Western Electric Company are used. These are the instruments which were acquired by Vitaphone under an exclusive license from Western Electric, and the use of which by Movietone is covered by an agreement between the Fox-Case Corporation and the Vitaphone Corporation. Since the telephonic equipment, which is the principal part of an installation, is common to both Vitaphone and Movietone, reproducing attachments for these two systems are now being so designed that both can be put on the one projection machine. This enables the exhibitor, after having secured installation, to reproduce both Vitaphone and Movietone pictures, using the same machines.

MANY advantages are claimed for the process just described. Of first importance, it is pointed out, is the fact that the sound and the picture are contained on the same strip of film, so that it is never possible for them to become separated. Neither is it possible for sound and picture to get out of synchronization. Thus it is not necessary for the operator to start the picture at any one spot. In case of film breaks, where it is necessary to cut out more frames in order to splice the film together, there is always a loss of the same amount of sound as there is of picture, so that this in no way disturbs synchronization.

The inclusion of the sound on the strip of standard film means that no extra cost or difficulty in handling is experienced in shipment of the pictures. In fact, these films can be handled in all respects the same as ordinary picture film.

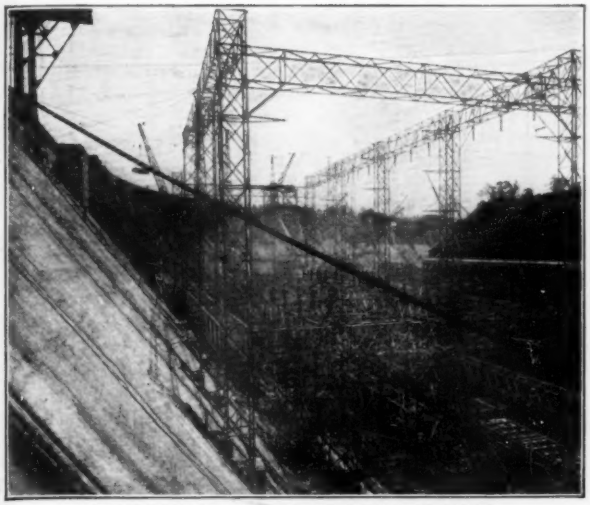
An advantage seen in the recording process comes from the fact that the recording cameras are an adaptation of the standard motion-picture camera; motor driven, and can be handled with the same facility as the ordinary camera. There are no unusual restrictions in the handling of this recording equipment, and it can thus be placed for any desirable shots, and changed from distance to close-up range at will without any preparation other than refocusing.

IN addition to having almost all of the outstanding advantages of other methods of recording and reproducing, the Movietone has one other, and that is its portability. Because of the fact that all of the recording apparatus can be mounted in a truck and carried from place to place, this newest process lends itself to the filming of news reels and the like. Thus not only the features and gestures of prominent persons, but their voices as well, can be preserved for posterity. Many news events will be found to be vastly improved in human interest when the sounds incidental to the actions are recorded and produced in absolute synchronism with those actions. The use of the equipment in portable form does not distract from its practicability in any way, as the apparatus mounted on the truck is practically identical with that which is ordinarily employed in the studio.



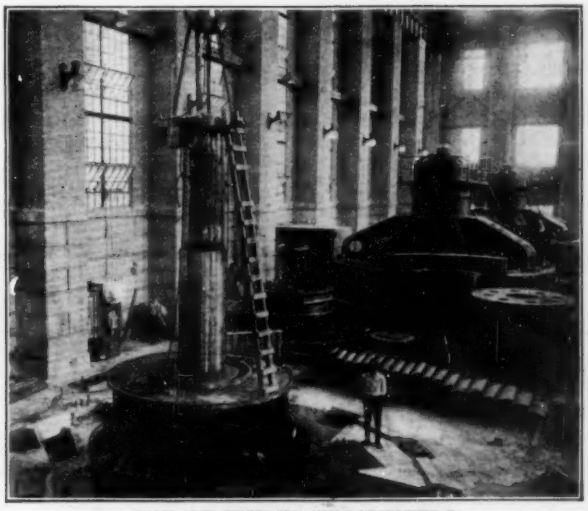
THE CYCLE OF RECORDING "MOVIETONE"

From the source, 1, come the sound waves, 2. They are picked up by the microphone and the fluctuating current is led by the wires, 3, to the amplifier. The stepped-up current follows the wires, 4, to the recording light, 5. Within the camera, 6, the film, A, is exposed to the rays of the light, B, through the slit C. The voice record in finished form is shown at 7



TOWERS THAT CARRY THE WIRES

These structural-steel towers support the wires which emanate from the transformers at the base of the towers



ONE OF THE WATER WHEELS

Here a shaft and one of the water-turbine wheels are being lowered into the position in which they will operate

World's Largest Artificial Lake

The New Martin Dam in Alabama Provides 530 Billion Gallons for Hydro-Electric Power Development

ALABAMA is building what is declared to be the largest artificial lake in the world. It will form part of the great hydro-electric project of the Alabama Power Company. The lake will be impounded above Cherokee Bluffs on the Tallapoosa River, and will have an area much greater than the city of Birmingham and all its suburbs. It will cover 60,000 acres of farm and forest land in three counties.

Compare the 530 billion gallons at Cherokee Bluffs with the 170 million gallons at Muscle Shoals. The Ashoken and Kensico reservoirs, from which New York City draws its supply, contain but 200 billion gallons combined. The Hetch-Hetchy reservoir, for San Francisco, has an initial capacity of 67 billion gallons, which will be increased as the city's needs expand to 116 billion gallons. The Pathfinder dam of the United States Reclamation Service contains 330 billion gallons.

THE new reservoir will assure four and one-half feet of water for navigation in the Alabama River to the Gulf of Mexico. The Tallapoosa flows into the Alabama. Furthermore, the danger of overflow in both the lower stretches of the Tallapoosa and the Alabama will be reduced to a minimum. This new body of water—christened Lake Martin—is 63 miles southeast of Birmingham. At one point it is 19 miles wide. An encircling driveway would be about 700 miles long and would be one of the most attractive scenic drives in the whole country. The dam was closed in June, 1926, when the Tallapoosa River began backing up and filling the lake.

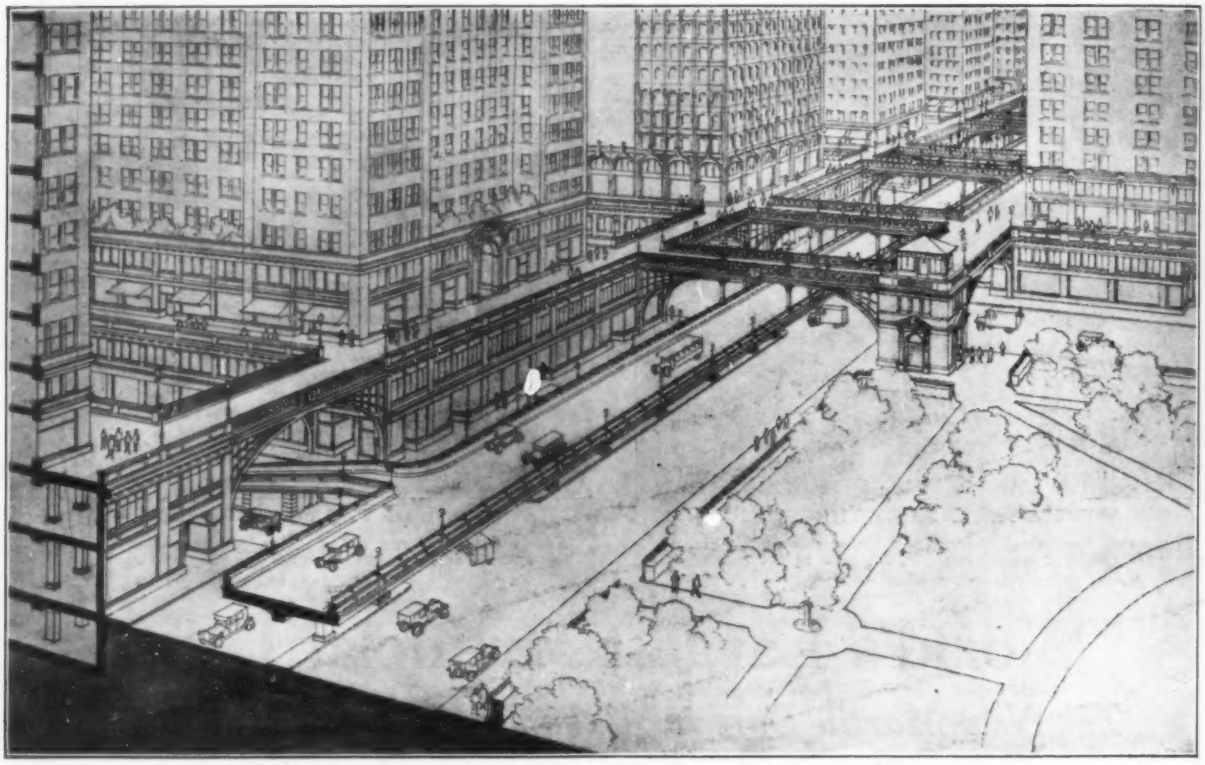
It was necessary, in order to construct this project, to build a city of 4000 people and to extend a railroad. Under the terms of the Federal Water Power Act, trees whose tops will protrude above water must be felled and the shore line must be swept clean for a distance of 20 feet above low-water level, to permit wave action and thus eliminate mosquito-breeding places. This work alone has called for the expenditure of one million dollars and the employment of 2000 workmen. Light logging methods were followed. Modified tractors were used for piling the refuse. Piling devices were employed that consisted of a cable and drum operated by the tractors.

The development will have three 45,000 horsepower generators, making a total of 135,000 horsepower. A fourth unit is to be added later. Each unit is sufficient to operate a row of street lights spaced 125 feet apart on each side of a roadway extending from Birmingham, Alabama, to Minneapolis. If a person will visualize four straight roads extending from Birmingham to Minneapolis, each having street lights at intervals of 125 feet along each side of the highway, he will obtain a clear conception of the enormous capacity of this new development.

The water wheels operate at heads varying from 150 feet, with the reservoir filled, to 90 feet when it is at the level of greatest draw-down. The dam, which has a maximum height of 200 feet, is 2000 feet long and is of the usual gravity type with flood gates at the crest of the main section. It is shaped like an elongated letter "S" with the main portion of concrete, 1250 feet long, curving upstream and the remaining portion reversed in curvature and composed of an earthen embankment built up over a concrete corewall.

PRIOR to the start of actual clearing of the land, permits to change the location of twelve cemeteries were secured and 900 graves were moved to location outside the flooded area where land was purchased by the company and donated to local community churches. It was also necessary to relocate several miles of railroad and 100 miles of highway. A plate girder railroad bridge and a reinforced concrete bridge 2500 feet long were constructed.

The total cost of the project will be 20,000,000 dollars in round figures, a considerable portion of which was required to secure and clear the immense area covered by the reservoir. So far as changing the map is concerned, this is one of the most elaborate projects ever undertaken in the southern states.



HOW PEDESTRIAN AND VEHICULAR TRAFFIC CAN BE DISPOSED

This view is supposed to be taken from a public square, looking towards the intersection of two streets in a part of the city where the proposed plan has been carried out. In the lower left-hand corner, the automobile runway and part of a building are shown in section. Here is depicted the benefit which would accrue to the third story by reason of the elevated walks. Shops facing on promenades of the kind shown would certainly be of great value. Thus the offsets would prove a source of revenue to owners, instead of a loss

The City of the Future

Proper Design of Highways, Buildings and Sidewalks Will Reduce City Congestion to a Comfortable Level

By ERNEST FLAGG

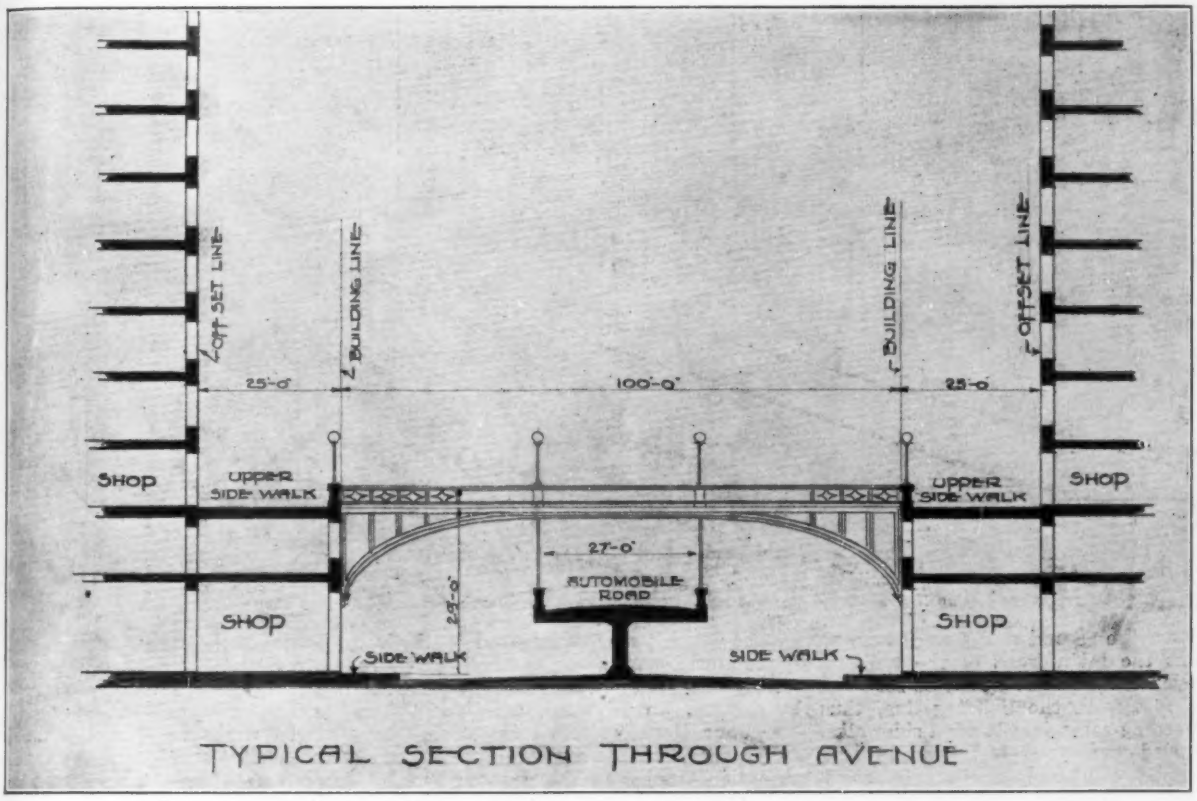
AMERICAN cities are now drifting into what will soon become an impossible situation, a fact which it is folly to ignore. Every day's delay adds to the difficulty and cost of doing what in the end must be done to correct it. It is fast being forced on public attention that streets intended for horse drawn vehicles and walk-up houses are inadequate for cities of three times the former height.

As the present width of streets is based on ages of experience, it is reasonable to suppose that they were properly proportioned for what *was* required of them. That they were so designed is proved by the fact that almost as soon as more pressure comes, trouble begins. It is clear, therefore, that if cities three times the former height are to be built successfully, street capacity must be proportionately increased. It would seem that this fact should be as clear as that one and two make three, yet most men here, otherwise intelligent, fail to grasp it. In Europe, perhaps from longer experience, the matter is better understood. No European city has been beguiled into our way of building. The European has object lessons before him which show what can and what cannot be done with impunity in this respect.

At the time of the first Zoning Commission in New York, inquiry was made of the principal European municipalities as to the greatest practicable height for buildings. The response was almost unanimous that it should be once the width of the streets. The justness of this conclusion appears from what we now see about us.

The reason that what appears so obvious to the European is not generally recognized here, is, as stated, probably due to lack of experience. We have no completed cities such as they have. Paris within the walls may be called a completed city and is probably the highest in the world, for the average height of the buildings is considerably greater than in any American city, notwithstanding all our building.

Anyone of intelligence who will examine conditions in Paris must admit that the streets have all they can properly care for, both as to traffic and light. Therefore, to suppose that two such cities could be successfully built, one on top of the other, on the same street plan, would be foolish. Yet we, on a much worse street plan, are merrily proceeding to build at least three such cities one on top of the other. The proof that these attempts are bound to end in failure unless some



USING ALL AVAILABLE SPACE FOR TRAFFIC

The centrally supported runway for fast automobiles here indicated would not interfere with the usefulness of the roadway below, because of its central supports. Space for the upper sidewalks is obtained by offsets from the building line above the second story. Offsets for light must be made in any event and as here arranged they would, by increasing street widths, be of maximum service in supplying light both for buildings and streets. Besides supplying width for sidewalks, they would greatly increase the value of the story at which they are placed, by making it available for shops. Bridges similar to the one indicated would cross streets in line with the sidewalks so that pedestrians could proceed without interruption by any kind of traffic

way is found for increasing street effectiveness, is now becoming so apparent that "he who runs may read."

The necessity for increased light is quite as great as the necessity for increased traffic facilities. As these gigantic buildings multiply, they darken each other and convert streets into deep, narrow, gloomy canyons. It is hard, therefore, to see how high building can continue without increased width of streets, for without that, neither sufficient light nor sufficient room for circulation can be had. As soon as this truth is admitted, the way becomes easier, for then it is no longer a question of what to do, but simply how to do a definite thing.

Congestion of streets is caused by interference. If progress through them could be continuous and fast for all classes of traffic, their capacity would certainly be considerably more than doubled. Therefore, the obvious way to obtain a great increase in effectiveness is to take advantage of this fact. At present three classes of traffic are moving, or trying to move, at the same level, all getting in each others' way. They are fast vehicles, slow vehicles, and pedestrians. The slow-moving vehicles set the pace and cross currents stop it altogether. It is clear that if these hindrances could be avoided, a great gain might be had independently of that supplied by any increased width required to carry out the plan.

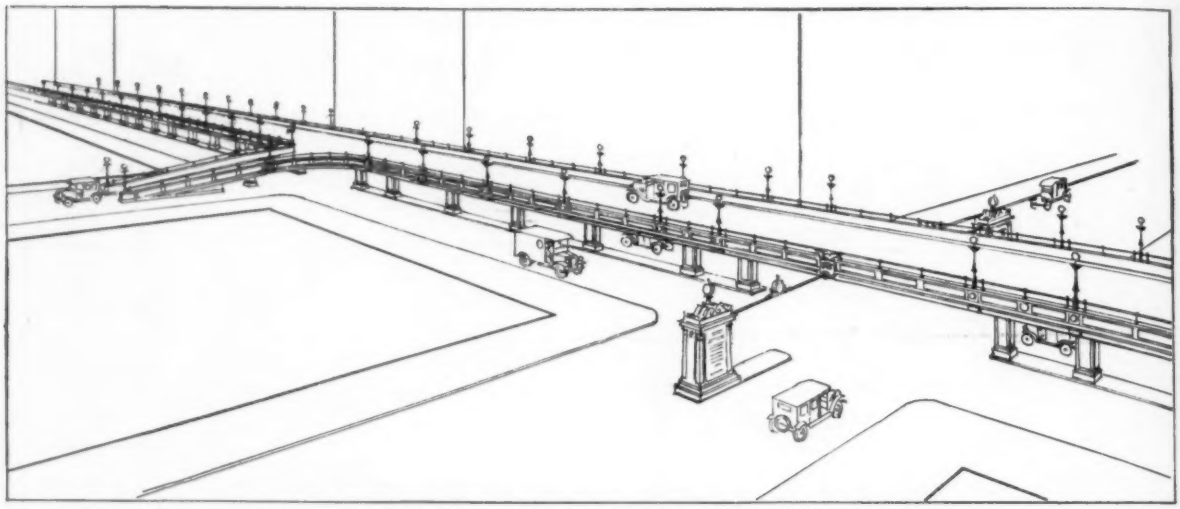
ONLY the day before I write I had an interesting and instructive illustration of this truth. Coming by motor to New York from White Plains through the beautiful Bronx Parkway, progress was fast, although the volume of traffic was enormous. For more than 20 miles there was no interference, for cross roads were carried overhead on bridges. All went well until within about two miles of the first grade crossing at 233rd Street, from which point back for these two miles there was a solid mass, so to speak, of automobiles. This was occasioned by the fact that in order to accommodate the cross traffic at 233rd Street, it was necessary to make periodic stoppages of traffic on the parkway. The consequence was that it took about as long to make the one crossing as to go the preceding ten miles.

A practical way, therefore, to obtain an enormous increase in capacity is to so separate the various classes of traffic that each can move independently at its proper speed and without interruption.

When this is once admitted, another obstacle to a proper plan is removed, for it is then no longer a question of what to do but simply how to make the necessary separation. As to that there is little choice. Space below ground is pre-empted for subways. The separation then must be made above ground if made at all, and it can only be done by the use of different levels.

It appears that the easiest and most practicable way to deal with fast moving automobiles is to provide runways centrally supported on the axis of the avenues so that the supports shall not interfere with traffic at the street level. Such an arrangement is here proposed. These runways are intended to do for automobile traffic what express tracks do for fast railway traffic. The construction of the runways can be understood by reference to the drawings.

Next, as to pedestrians: To increase light for buildings and streets, offsets from the street line are proposed



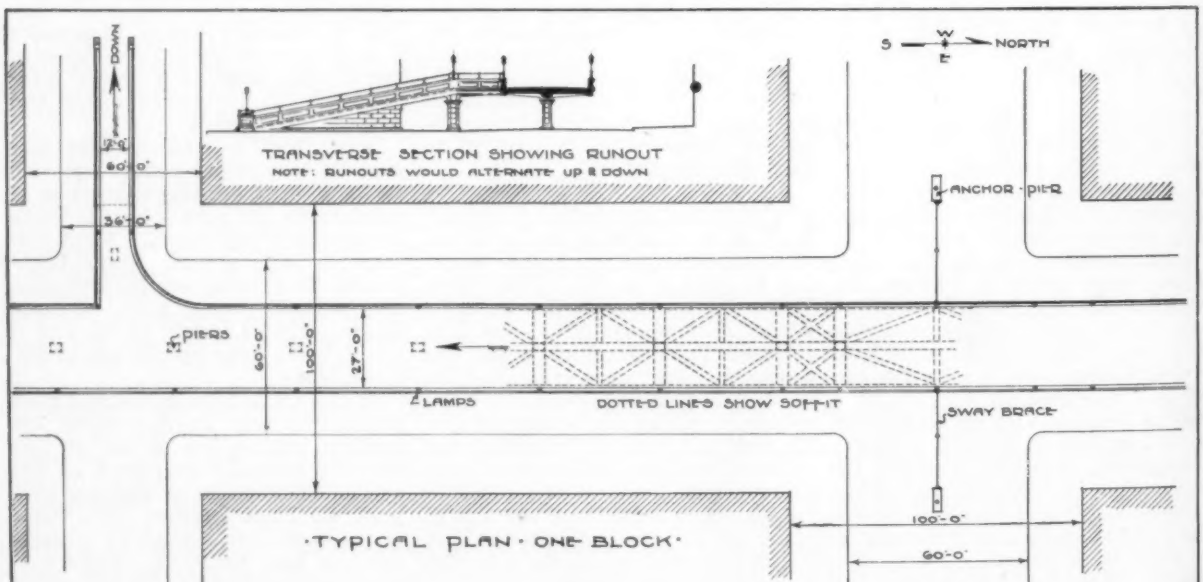
EXPRESS HIGHWAYS CAN CROSS OTHER STREETS IN THIS WAY

This drawing indicates one of the express automobile runways crossing a wide street. The small structure on the axis of the transverse street indicates an anchorage for guying the runway to prevent side motion. The anchorage being on the axis of the street would not interfere with traffic. Where there is an incline, no other brace is needed. The construction of the runway and the means for bracing it are shown in plan below

above the second story, as stated, so that the main front of the building beyond this height would be set back 25 feet from the building line, thus affording room for elevated sidewalks, carried across streets by bridges and through old buildings at the story height. Thus in business districts two tiers of shops might be had, one at the street level and one at the sidewalk level, (see all drawings). The sidewalks would naturally add greatly to the value of the second story above the ground and afford delightful promenades where pedestrians could move in comfort, safety and without interruption. They would be reached by elevators in private buildings and by public elevators and escalators.

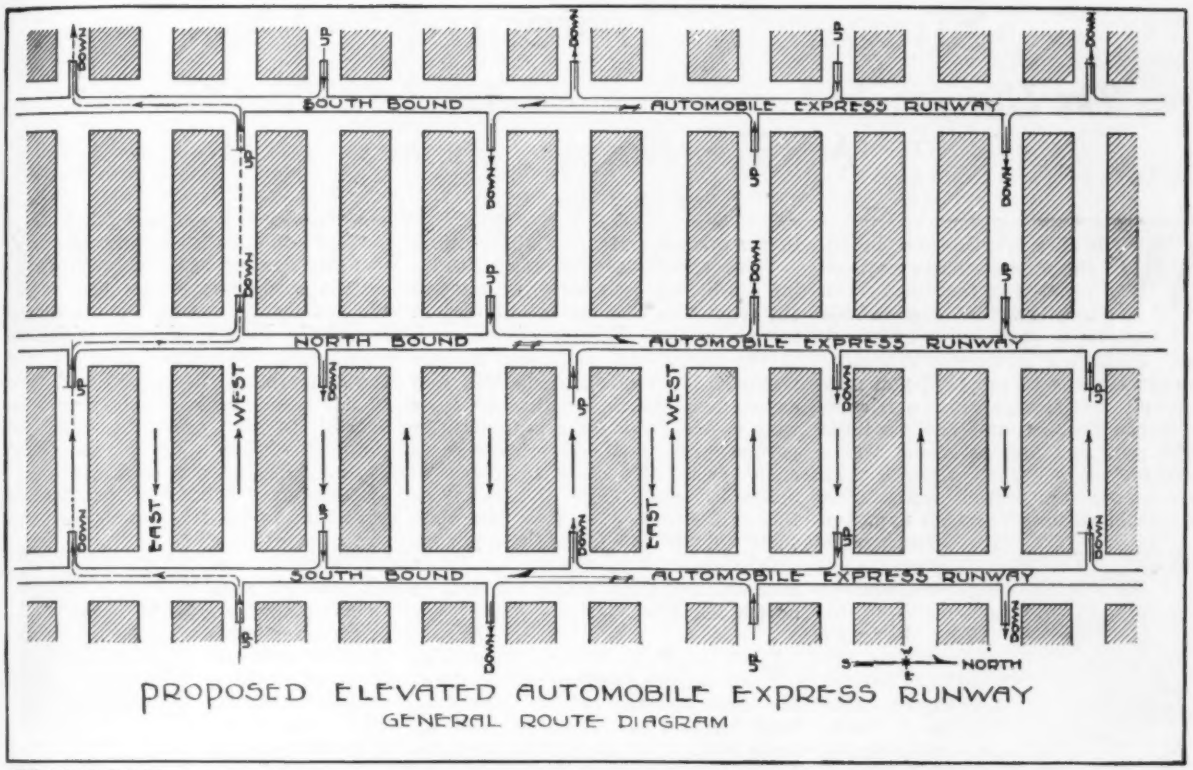
For greater convenience in explanation, the perspective drawing has been taken as if from a public square, the view being such as would be had from Bryant Park, Manhattan, looking towards Sixth Avenue and 42nd Street, supposing the city to have been treated in this way at that place. The small tower-like building in the corner of the square is supposed to contain elevators or escalators connecting with the sidewalks, street level and subway below. The gain in effective width at sidewalk level would be 50 feet and at runway level 30 feet, but the greatest gain would be in the avoidance of stops and more speed, the total increase in efficiency being about 200 percent.

A still further great gain might be had by removing present street obstructions. The elevated structures and street-car tracks are doomed in any



CONSTRUCTIONAL DETAILS OF THE PROPOSED EXPRESS HIGHWAYS

This drawing indicates the proposed method of constructing the express automobile runways. Being centrally supported, it is necessary to provide against lateral movement. No bending could occur because of the truss-like construction of the frame of the roadway, and side movement is guarded against by the anchorages on the axis of some abutting streets and by inclines on others. The construction would be in the nature of a great truss horizontally disposed on its side, supported by a single line of uprights and braced against lateral movement by inclines and guys to suitable anchorages placed on the axis of abutting streets



All Illustrations by the Author

HOW EXPRESS HIGHWAYS COULD BE PLACED TO BE MOST EFFECTIVE

This drawing represents a section of the city plan, showing avenues and cross streets with automobile runways on the axis of the avenues arranged alternately for one way traffic in opposite directions. Separate inclines for ascending and descending are supposed to be provided but few are shown on the drawing. To cross an avenue, a car would go up, join the traffic, work to the other side and descend by the next incline down. In this way one could cross all the avenues, without interruption, by simply going a little further. This plan should be studied in connection with the other drawings given on the three preceding pages

event and the sooner they go the better. In order to understand how great an obstruction these are, one has but to imagine an elevated railroad on Fifth Avenue, New York City, such as exists on Sixth Avenue, or car tracks like those on Broadway. In either case it is safe to say that the efficiency of the street for surface travel would be reduced from 30 to 50 percent.

Another cause of street congestion is due to the unloading of merchandise on sidewalks. All new buildings of the warehouse type should have loading platforms on the premises. Street openings and the dumping of building material on the roadways also cause congestion which might be remedied by more stringent rules.

All that has been said so far concerns conditions above ground. We have now to consider congestion of subways. Of the fourteen longitudinal avenues suitable for such roads in Manhattan, eight are now occupied either by elevated structures or subways. All these lines are carrying more than twice as many people as can be accommodated on them in decency and comfort. It may therefore be said that if every avenue had a subway under it, their total capacity would not be more than needed right now. Yet the building program has hardly begun, for at present, while the common practice is to build from 15 to 30 stories, yet it is doubtful if ½ of 1 percent of the area of the island is so occupied. The exhaustion of this means of transit is therefore plainly in sight. It has been suggested that there could be deep tunnels right and left under the rivers to Long Island and New Jersey, but their cost would be great and their construction slow. They will undoubtedly be needed in the future but cannot be relied on for immediate relief. It seems as if that might be had to a great extent by means of the viaducts, or runways for automobiles already described. They would cost less than subways and if used to full capacity might each carry in busses as many passengers as a subway.

IT seems probable that in the future busses are to play a most important part in bringing passengers into and out of the city. They have the advantage that by different routes they can reach all parts of the suburban regions, bringing them into direct communication with and through the city. This kind of transportation also has the advantage that it can be put in operation with the least delay.

The population of Manhattan is decreasing while its industries are increasing by leaps and bounds. If the movement continues it will soon be necessary to transport several million persons who all want to reach work at about the same time and go home at about the same time. If the home is far away this will not only involve great hardship on the worker, but an immense economic loss both in time and cost of transportation. It is therefore evident that the denser the population in the immediate vicinity of industries, the better, provided the homes are healthful.

There will always be many who, to obtain open surroundings for their families, will be willing to undergo great personal inconvenience, but the large majority will prefer to live near their work and they ought to be allowed to do so. But if restrictions are made on density of population within the city and near it, all available land will soon be sparsely occupied, and persons seeking homes will be driven further and further off. Therefore, instead of such restrictions, a sound policy requires the establishment of an adequate standard of light for rooms, as this plan provides.

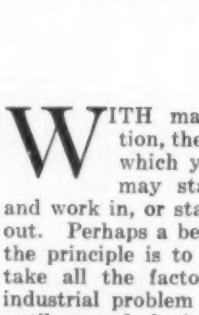
¶ *The second installment of this article will appear next month.*

Successful Inventors---IX

The Ultimate Use of an Invented Article is What Counts, Say Two Partner-Inventors

By MILTON WRIGHT

WITH marketing an invention, there are two methods which you may use. You may start at the outside and work in, or start inside and work out. Perhaps a better way of stating the principle is to say that you may take all the factors of a particular industrial problem and analyze them until you find the invention which provides the solution. Or you may take a specific invention and analyze its possibilities until you hit upon the best merchandising system for using it to its fullest extent.



P. E. LOCKHART

The former method is the one used by P. Everett Lockhart and Charles J. Hauk, Jr., chairman of the Board of Directors and President, respectively, of the Industrial Engineering Research Company, an organization founded six years ago to solve industrial problems. Their best-known work has to do with a roll of package advertising tape used in lieu of cord by grocers and other retailers in fastening packages. In establishing this system of advertising, they have had to be not only inventors but business analysists and salesmen as well. Their reasoning in finding an ideal invention and the way to make the most of it is something which many inventors might do well to study.

To dig out the story of just how their idea was put over, Lockhart and Hauk sat down with the writer and answered frankly the questions we put to them. In the quotations which follow it is sometimes Lockhart speaking and sometimes Hauk.

"Just how did you arrive at the little machine and the roll of gummed paper which you now use, carrying the advertisements of nationally known advertisers?" we asked.

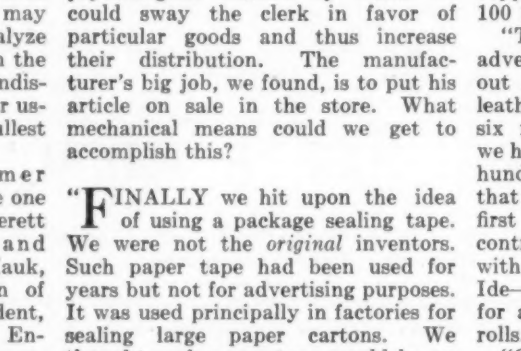
"We started to attack this problem in its broadest aspect, was the reply. "We figured that the problem of business for the next ten years would be one of distribution. Engineers and mechanics have become so efficient that anything can be made. The best minds of the country have been focused on producing, with the result that there is a lack of efficiency in our present systems of distribution.

"Now there was our problem. Studying it a little more closely, we came to the conclusion that the solution lay in increasing the efficiency of the clerk in the store. We considered various methods for accomplishing this and came to the conclusion that what we were seeking was some automatic or psychological method by which we could sway the clerk in favor of particular goods and thus increase their distribution. The manufacturer's big job, we found, is to put his article on sale in the store. What mechanical means could we get to accomplish this?

"FINALLY we hit upon the idea of using a package sealing tape. We were not the *original* inventors. Such paper tape had been used for years but not for advertising purposes. It was used principally in factories for sealing large paper cartons. We thought such paper tape would be an excellent means of calling attention to articles sold in the stores.

"We looked around for devices we could use and located what we thought we wanted in the hands of a company in the throes of bankruptcy. As time went on, we learned that neither the tape nor the machine to feed it out was ideally suited for our purpose, but it looked good and so we acquired it. We have since had to do considerable inventing to perfect it.

"We now had the invention which we thought would solve our problem. True, we were not the original inventors, but we *owned* the invention, and it was up to us to see what we could do with it. We called on the retail trade and placed our machines in stores."



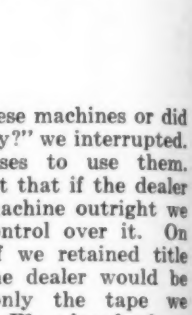
DIFFERENT USES OF THE TAPE

Gummed paper with advertisements printed on the untreated side, are used as labels and for sealing packages in place of cord or other fastening

"Did you sell these machines or did you give them away?" we interrupted.

"We sold licenses to use them. We had figured out that if the dealer owned the little machine outright we would have no control over it. On the other hand, if we retained title to the machine the dealer would be obliged to use only the tape we supplied to him. We placed about 100 machines, mostly in drug stores.

"Then we called on prospective advertisers. That is where we wore out a lot of shoe leather. It was six months after we had placed our hundred machines that we made our first advertising contract. This was with George P. Ide—1800 dollars for advertising to be placed on 2000 rolls.



C. J. HAUK, JR.

"Other advertisers followed. We took all sorts of them—drug manufacturers, meat packers, soap makers and so on. We even took advertisements for Famous Players motion-picture features. The dealers protested about the 'movie' advertising, however, and we discontinued it.

"As we went along, we were experimenting with one type of tape feeding machine and another; with advertising one kind of product and another.

"Our tape-feeding machine had to be improved constantly. The first machine we used had more than 150 parts. The machine we are using now has only three parts. The trouble with the machines we used at first was that they were too perfect. They would work splendidly in a laboratory but with the abuse they would get in the average store they soon got out of order. To be inventors had been farthest from our thoughts in the beginning, but we were obliged constantly to keep working on mechanical simplification and improvement.

"In other ways, too, we were laboring in an untilled field. For example: no printing had ever been done on gummed-paper rolls before. We started with one color, increasing the number of colors used until today we can use practically any color combination."

"But a business such as you have undoubtedly called for a considerable outlay of money, especially when you were such a long period with practically no income," we interposed. "How did you raise capital?"

"AS the possibilities of the business developed, a small group of men who had confidence in us advanced us a considerable sum—80,000 dollars."

"But were the men who put up the money really justified from a business standpoint? Was it anything more than a mere gamble with them?"

"Yes, we think they were justified. A firm of bankers looked into our proposition, analyzed its possibilities and offered us 100,000 dollars for a half interest. We feared that in time we might lose control, so we turned down the offer. The bankers certainly provided some justification for the friends who later advanced the funds."

"How many stores are using this advertising paper tape of yours?"

"About 60,000 stores, most of them groceries. This includes about 80 percent of the chain stores of the country.

"And how many advertisers are using your method?"

"About 40 national advertisers, manufacturing such well-known products as: Borden's Condensed Milk, Kraft Cheese, Muller's Macaroni, Colgate's Soap, Bon Ami, Phoenix Cheese, Beech-Nut Products, Sapolio and Duz."

"And what is the basis upon which they pay you?"

"That depends on the quantity. For smaller quantities the price is 35 cents per thousand advertisements and for larger quantities 25 cents. This price includes everything—designing, manufacturing, printing and the like."

"What would you do in the event that you did not have enough advertising?"

"That is a question which fortunately is not confronting us. At the present time we have more advertising contracted for than we can distribute on the tape. Placing the machines in stores is a bigger problem with us than getting advertising. It has become easier, however, as the dealers come to appreciate its advantages over the use of cord. Formerly, we had to use rather high-powered sales methods. The method of one of our salesmen was particularly interesting. He would walk into a grocery store where a woman was buying an order of groceries and wait until the grocer was wrapping them up. Just as the grocer took up a piece of string to wind about the bundle this salesman would raise his hand and in a loud commanding voice say, 'Stop!' Before the surprised grocer knew what it was all about the salesman had whipped a machine out of his pocket, torn a strip of the sealing tape, sealed the package with it and handed it to the customer with a bow. As she left the store he would begin demonstrating to the grocer what a wonderful little machine it was and how desirable it was to seal up packages with paper tape instead of tying them with string."

"What had become of the *original* inventor of package sealing tape?"

"HE faded from the picture long before we appeared on the scene. Probably neither he nor any of our predecessors made much money out of the idea."

"To just what would you attribute their lack of success?"

"In the first place, their application of the invention was not the one best suited for profits. They had a roll of gummed paper tape and a machine for feeding it out and cutting it off. That was all right as far as it went, but it did not go far enough. Our idea of a mechanical invention was one that would serve some purpose beyond its mere mechanical function.

"To get to the point which we are trying to make, consider an automobile. It travels; that is its mechanical function. To make its operation profitable, however, it has to do something more than merely function mechanically; it must transport people or merchandise. With gummed-paper tape and the machine for using it, the function was to seal bundles, but it was not until an additional function was added—not until it became a sales help—that profits could be made."

"But using this gummed-paper tape is more efficient than cord, isn't it?"

"Yes, it is quicker, neater and less bothersome."

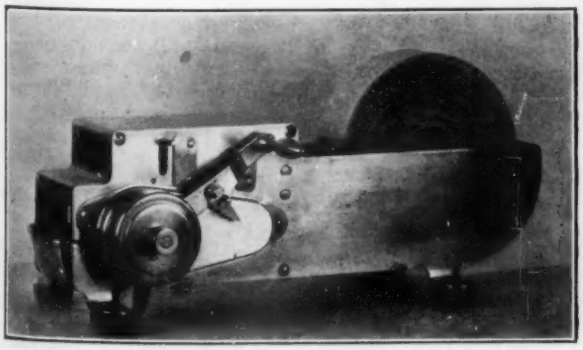
"THEN why is that superiority not enough to insure a substantial profit to the manufacturer?"

"Because the unit of sale is too small. Inventors often fail to consider the problem of the man who is going to sell the invented article. In the case of the gummed-paper tape, probably the biggest obstacle facing the original manufacturers was the fact that the sale was made to the retail dealer. Tape being so efficient and economical, the retail dealer could use only a few dollars' worth a year. It was impossible for a manufacturer's representative to call on enough storekeepers to make a decent living.

"By having advertising on the tape, however, the advertiser, not the storekeeper, becomes the individual sales prospect. The unit sale becomes thousands of times as great as the unit sale of plain gummed tape. This is so because advertisers are buying tape in large quantities for distribution to thousands of stores. The manufacturer's representative can now call on a relatively small number of prospects, but have a large volume of sales and make a good living."

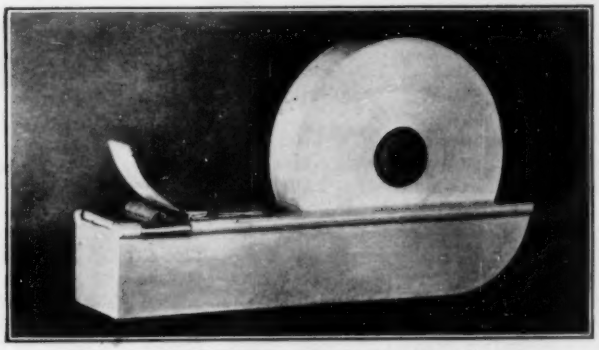
"But your theory would apply only to yourselves, wouldn't it?"

"Not at all. The money from inventions in any field is made from sales. Whatever line an inventor works in, he should make some market analysis or somebody should make it for him. Too often an inventor is inclined to think he can take it easy after he gets his patent. He cannot. The patent is only his starting point. He needs a patent, yes, but, after all, the important thing is the use he makes of it."



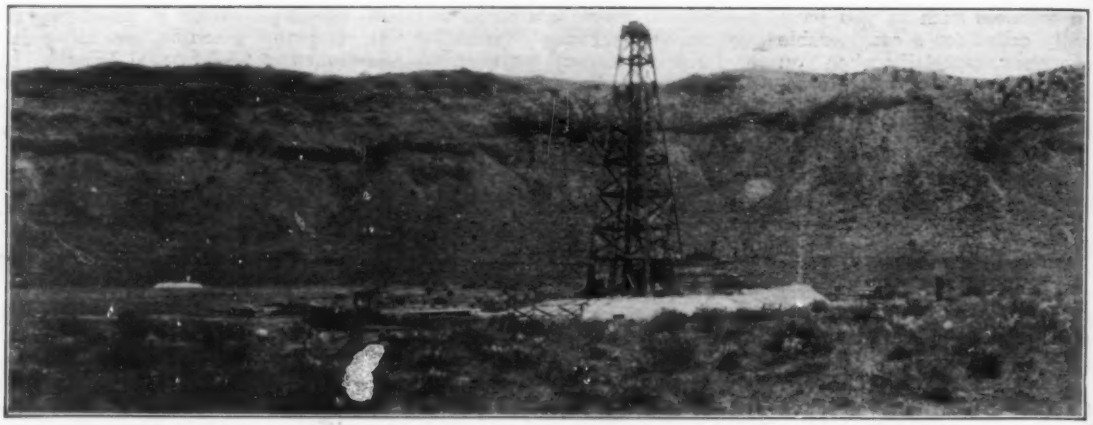
THE ORIGINAL TAPE DISPENSER

It was complicated in construction, containing many parts



THE IMPROVED TAPE DISPENSER

Far simplified, it is more parctical than the original one



INTERIOR OF METEOR CRATER, AND ONE OF THE EARLY DRILL HOLES

The first exploration holes were drilled in the center of the Crater, on the reasonable theory that the round Crater could have been made only by a vertically falling projectile. But reasonable theories are often exploded by mere facts, and so it was later discovered that a slanting impact would also produce a round Crater. Most scientists accept the meteoric origin of the Crater. "I have examined the Crater on the ground, as well as the other evidence," says Prof. Henry Norris Russell of Princeton University," and I am thoroughly convinced of its meteoric origin."

The Most Fascinating Spot on Earth—III

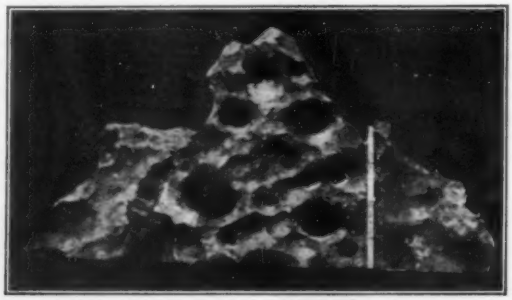
The Composite Iron Mass Beneath Meteor Crater Is Believed to Be About 500 Feet in Diameter

By D. MOREAU BARRINGER, Jr.

IN addition to the evidence of abrasion on the shale-balls, there is another and more cogent reason for believing that the mass which made Meteor Crater was a cluster of small pieces rather than a single huge iron body. One solid piece of iron big enough to make the Crater would have a pronounced effect on a magnetic needle immediately above it—and yet several accurate magnetic surveys, both with compass and dip-needle, have shown no such effect. If, however, the mass were a cluster of small pieces, the magnetic poles of those pieces would tend to neutralize one another, and therefore produce no noticeable effect at the surface of the ground. This has been demonstrated by experiment.

Now if the usual shape of the individuals of the swarm is one of rounded outline, why are not the Canyon Diablo meteorites also rounded, and why do they show, instead, the greatest irregularity of shape? Almost always their surfaces are pitted and dented with the so-called "thumb-marks," and frequently they have deep pits and cavities that in some cases extend entirely through the mass. I believe the answer is to be found in the theory I have just mentioned, that the irons found at the Crater, and many other irons which have been picked up as complete individuals, are simply the remnants of once rounded meteorites which have failed to oxidize owing to their lack of chlorine.

The usual explanation of the holes and dents in meteorites is that they were caused by the rush of highly heated oxygen through which the meteorite fell to earth—that is, that they were literally burned into the iron. But this does not seem to agree with the fact that the Widmanstätten figures disappear when the iron is heated to a far less degree than that necessary for fusion, and that all those irons which exhibit the burned-out holes and dents also exhibit the Widmänstätten figures to the very edges of the specimens. And—what is to my mind a still more convincing proof—I have frequently found the holes in the surface of iron meteorites partly or wholly filled with iron oxide, or iron shale. If the hole was caused by fusion during the meteorite's flight through the air, surely the liquid iron would not have remained in the hole, to oxidize subsequent to its fall to earth.



TYPICAL METEORITE

Astronomers have observed that when a comet's head transits the sun, it becomes invisible, showing that it is not a single solid body of matter

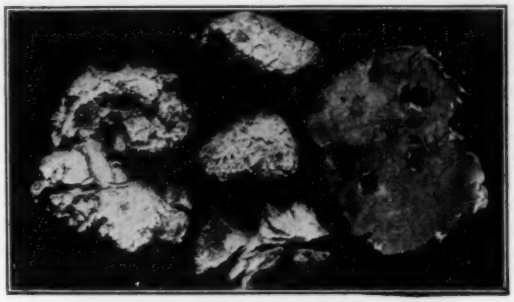
Here another question presents itself, and one on which I have sufficient data only to speculate, not to form any theories. If the thumb - markings typical of iron meteorites are caused by terrestrial oxidation after the fall, then those meteorites which have been seen to fall and which are picked up shortly afterward should lack them. I have examined the record of quite a number of meteorites which have been described in technical papers by Dr. Merrill, of the Smithsonian Institution, and others, and so far the hypothesis has been borne out by the facts. When a meteorite has been seen to fall and subsequently has been picked up, it has no thumb-marks. When it has thumb-marks, it was not seen to fall, and therefore may have been on earth a sufficiently long time before its discovery for the ordinary rusting agents of air and water to produce those marks on it. As I have said before, I cannot state this as a theory with any degree of confidence, but I believe that a further study of the available data will bear it out.

About 75 percent, or more, of the meteorite material found around the Crater has been oxidized. When sufficient allowance is made for the

oxidized material which has been carried off by wind and rain, the figure may be even higher than this. We are safe in assuming, therefore, that over 75 percent of the original bulk of the meteorites in the cluster was of the oxidizable variety of iron. Now we know that where the last churn-drill hole encountered the upper part of the buried cluster, oxidizing conditions obtain. There is no permanent water-level in the ground at this depth, and the surface waters can penetrate to and through the cluster, carrying oxygen with them. It is a fair assumption, therefore, that at least a large part of the buried mass, once solid iron, is in the form of iron shale.

MY idea of the present condition of the mass, then, is about as follows: At and near its center there will be nothing but rounded pieces of iron, more or less in an oxidized condition. The average size of the individuals, to judge from the average size of those found outside, will be in the neighborhood of five or ten pounds. Without doubt, however, there will be some of much greater size, possibly of many tons in weight. These naturally would be less oxidized than the smaller pieces. But I think the average will not be far from ten pounds, and the degree of oxidization of the average will be 50 percent or more. Near the edges of the cluster, sand and crushed silica will begin to appear, mixed in between the individuals. This will be more abundant as the outside of the cluster is approached, until there remain only a few meteorites scattered here and there through a jumbled mass of rock-fragments and silica dust.

Near the bottom of the mass I should expect to find quite a concentration of Variety B of the metamorphosed sandstone—the variety that has been fused, and has cooled and hardened to the form of quartz glass. And for a short distance around the mass itself I should expect to find fairly abundant staining by iron and nickel vapors, such as was found in very much smaller quantities in the track of the projectile, near the center of the Crater. To the north, and to a lesser degree to the east and west of the mass, the rocks are completely crushed and dislodged. To the south, however, the rocks within a very short distance of the projectile should be solid; for when the penetrating force of the projectile ceased, so also did its shattering force on the rocks ahead. I do not believe that it shattered much rock ahead of it which it did not immediately throw either out of the hole or backward into the lower portion of the Crater.



NICKEL-IRON SHALE

Irregular masses found on the plain near the Crater. They represent decomposition of shale-ball meteorites. One is cut in section and polished

So far as the last drill-hole can testify it bears out this description of the condition of the mass. All the meteoric material encountered by it was oxidized, and seemed to be scattered in the shape of rounded balls through the crushed sandstone. The deeper the hole got the more abundant became these balls, until, as I have said, they were forming about 75 percent of the ground when the drill finally stuck and broke.

I have omitted, so far, practically all reference to the estimates of the projectile's weight, and the methods by which those estimates were arrived at. This is because this question is perhaps the least well-known of any of the main points about the phenomenon. There are several unknown factors, and hardly enough known ones with which to effect an accurate solution.

The first method used was suggested by a reference in an old handbook on artillery, to a formula for computing the probable effect of bombarding masonry with round shot. Roughly, this formula stated that where the diameter of the shot was 1, the depth of the hole would be about 2, and the diameter of the hole about 7. Applying this to the observed features of the Crater, and considering the average depth of the original hole before it was partly refilled by returning fragments to have been 1100 feet, we find that a diameter for the projectile of 550 feet closely satisfies the formula.

ROUGH though this computation seems, it is checked fairly closely by others which go into more refinements. Dr. Elihu Thomson and Dean Magie of Princeton, both of whom have taken a very great interest in the problem for a long time, have made a number of calculations on this point. They assumed speeds for the projectile of from two to ten miles a second (faster than which it is unlikely to have been moving) and made rough estimates of the amount of work involved in crushing and largely throwing out of the hole some 350,000,000 tons of rock. Their results have usually given somewhat smaller sizes for the projectile than 550 feet in diameter, so that the weight we now accept is that of a sphere of about a 400-foot diameter, which would weigh about ten million tons. As the mass was probably more in the nature of a load of shot in a shot-gun than that of a ball, its diameter would

MORE EVIDENCE

The immediate neighborhood of Meteor Crater has supplied more iron meteorites than all the rest of the world combined

THE SHAFT IN 1903

In 1903 a 200-foot shaft was sunk inside the Crater. Quicksand was encountered and therefore the work was stopped

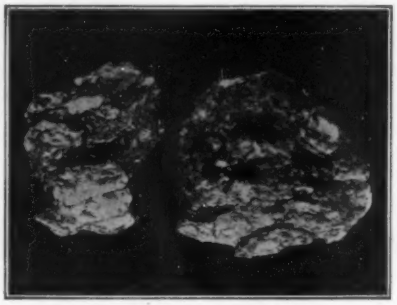
be somewhat greater than this, but the weight would be about the same.

Another subject on which I have not touched is the question of the age of the hole. We know definitely that it cannot be less than 700 years old, for a cedar tree with that number of annual rings was found growing on the rim. And we feel sure, from the lack of erosion, particularly of chemical erosion on the limestone, that it can not be more than 5000 years old. Between these two limits, then, will probably be found the true age of the Crater.

In this connection there may be a good deal of interest in the fact that the Navajo Indians, who inhabit that region, are said to have a legend about the Crater that coincides very closely with what actually occurred there. By itself, a hole in the ground would not be likely to stir the imagination of the Indians, for they are perfectly familiar with the many volcanic craters of the San Francisco Mountains 50 miles or so away and attach no importance to them whatever. But about the Meteor Crater they have very marked superstitious beliefs, and it is said that they have a legend which describes the descent of one of their gods from the sky, in clouds of fire, to bury himself in that particular spot. Whether any weight should be attached to this story I do not know. It is true that the Indians will not carry away or use any of the iron meteorites. Needless to say, the newspaper writers have always placed great emphasis on this legend.

A ROUGH outline of the principal facts, then, is as follows. We know that an iron meteorite made the hole. No terrestrial explosion could cause it without disturbing the underlying rocks, no means other than a slanting impact could cause the symmetry of the rim, nothing but a smashing blow could pulverize the grains of the white sandstone. (I can take a handful of sand and reduce it to powder with a hammer, but I will not undertake to do it with steam). The fused silica, the absence of igneous rocks, and the coincidence of the meteorites and the hole are further proofs.

If a meteorite made the hole, it must have either remained in it, or bounced out, or flashed into vapor and disappeared. It could not have vaporized for the vapor would have left abundant and indestructible stains. It could not have bounced out, or the hole would be a trough instead of a circular basin. Therefore it must still be in the hole.



SHALE-BALL METEORITES

Dug out of the silica. They have nickel-iron centers surrounded by oxides

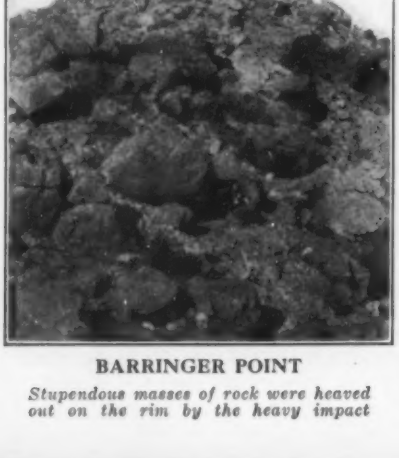
Its chemical composition can be inferred from the specimens outside the hole, for there is no reason why they should differ in composition from the whole mass. Its location is determined from the symmetry of the crater. And from the shape of the shale-balls, and the lack of magnetic effect on the surface, the theory that the mass is a cluster instead of a single body is deduced.

This is about as far as observation, deduction, and speculation has carried us toward an accurate visualization of what happened when this gigantic missile from space struck the Arizona desert, and what has since happened to it. But the fascinating fields for investigation that open out from here are innumerable. To an astronomer it gives promise of shedding a flood of light on theories of the origin and building up of our solar system and others like it (if there are others like it.)

A GEOLOGIST is attracted by the evidences to be found of the behaviour of rocks under sudden stress, and the later effects of chemical action, underground, on this comet which has suddenly turned into an ore-deposit. A chemist or a physicist will want to investigate the very peculiar properties of the nickel-iron alloy of which the iron remnants are composed, and to understand further the formation of the unusual compounds of metals found in it. An archeologist will be interested in finding what effect, if any, the fall of the meteorite may have had on a primitive race that may have inhabited the region at the time. And many other branches of science will be affected, directly or indirectly, by further disclosures at the Crater. The greater part of these investigations must wait, probably, until further exploration has shown up the main mass of the meteorite itself—a consummation which we are now trying hard to bring about.

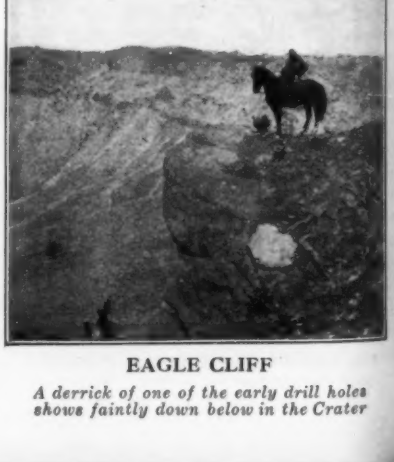
One very interesting by-product of the investigation is the resurrection of the theory that the moon's craters are not volcanic, but are the results of impacts similar to that which made the Arizona Crater (Daniel Moreau Barringer, Sr., "Volcanoes—or Cosmic Shell-Holes," SCIENTIFIC AMERICAN, July, 1924). The two chief objections to this have been: first, that practically all the lunar craters are round, and therefore the projectiles, to have made them, must all have fallen vertically, which is not likely; and second, that the moon has 30,000 craters, while the earth has only one little one. The first objection will be disposed of by the rifle-and-mud experiment I have mentioned, and the second by a consideration of the fact that there is no erosion on the moon and never has been, and therefore that the records of impacts may remain visible there for millions of years, while those on the earth have been obliterated in a few score thousand years. With these two objections removed, I think the theory, if not proved, is at least worthy of most serious consideration.

THROUGHOUT this discussion, I have not stopped to give the proper acknowledgments of the sources of my information. Whatever I have learned about the problems at the Crater, I owe to my having had the privilege of being closely associated with the men who have done the work and spent the study on it that the phenomenon deserves, chief among them being my father, Dr. Elihu Thomson, Dean Magie of Princeton and a few others.



BARRINGER POINT

Stupendous masses of rock were heaved out on the rim by the heavy impact



EAGLE CLIFF

A derrick of one of the early drill holes shows faintly down below in the Crater

Wide World

HARVARD COLLEGE CREWS AT PRACTICE

The shells shown in this illustration are of the eight-oar type discussed in the accompanying article. The amount of work done by the oarsman under racing conditions has been carefully studied and the results are given

What Determines Rowing Speed?

Tests in Specially Constructed Tanks Have Revealed Some Interesting Data Relative to Work Performed by Oarsmen

By LEWIS HOBART KENNEY, M.E.
Coach, Malta Boat Club, Philadelphia, Pennsylvania

ROWING has been a competitive sport for centuries, but the racing shells of to-day have been developed during the past 100 years from various types of racing boats. In this article we will outline some of the developments in rowing equipment which have taken place since the days of the racing boats, the laboratory methods for determining the power required to propel racing shells, and the application of laboratory data to regatta data for the purpose of determining the work done by oarsmen under racing conditions.

The developments in hull design have been progressive and have occurred in logical sequence. The first were introduced by English boat builders, but later others were introduced by American boat builders. The primary object of the improvements was to increase propulsive efficiency and by this means obtain higher racing speeds.

It may be of interest to trace the transformation of the racing boats used in England about 100 years ago into the racing shells of to-day. The racing boats were about 35 feet long, six feet beam, and weighed about 700 pounds. The first development was the outrigger used by Anthony Brown, at Ouseborn on the River Tyne in 1828, a device to support the thole pins—later on the rowlock-outboard of the boat instead of on the gunwale. The second development was the reduction in the beam of the boat made possible by the outrigger.

The reduction in beam led to a study of hull design in relation to stability, structural strength, and method of construction, which has resulted in a very much improved form and reduction in weight of hull. The view was held, and correctly, that by reducing the hull weight without sacrificing structural strength, the racing speed could be increased for a given power application. The designs in use to-day and the materials at present available provide racing shells which will withstand the severe strains developed under racing conditions, and which are of minimum weight.

Wide World

NEW TYPE OF SHELL

Walter Hoover, famous single scull oarsman, testing a new shell made for the United States Naval Academy. It is constructed of duralumin, is 26 feet long, and weighs only 26 pounds

The merits of the outrigger were not immediately recognized and it was 18 years after its introduction in 1828 that Cambridge and Oxford rowed their first race in outrigged boats. About 1860 the eight-oared outrigged boat without external keel, closely resembling the racing shell of to-day, came into general use.

While developments in hull design were in progress, thoughtful consideration was being given to ways and means for improving oar design, and in 1842 the curved blade or "spoon" oar was first used in boat races. The proper dimensions of the oar for supporting the severe loads applied under racing conditions have since been determined and the result is a reduction in oar weight.

One other important subject studied along with the others is the equipment which has to do with the oarsman's comfort and which enables him to apply power to the oar most effectively. This equipment includes the foot stretchers—made adjustable to meet vari-

WORK DONE BY A SINGLE SCULLER
ON
SCHUYLKILL RIVER COURSE, PHILA, PA.
REGATTAS
1922 TO 1926 INCLUSIVE

Event	Number Races	Time Min.	Time Sec.	Miles per Hour	Feet per Min.	Resistance lbs.	Foot lbs per Min.	% Horse Power
¼ Mi. Dash	15	1	19	11.36	1000	17.3	17400	52.7
DISTANCE 1 MILE*								
Junior	2	6	49	8.81	775	10.7	8300	25.2
" 145lb	1	6	36	9.09	800	11.3	9000	27.3
Intermed.	2	7	2	8.19	720	9.3	6700	20.3
Assoc.	2	6	50	8.78	773	10.4	8200	24.8
Senior Y	2	7	8	8.41	741	9.8	7300	22.1
" 145lb	1	7	7	8.42	742	9.8	7300	22.1
DISTANCE 1¼ MILES								
Junior	12	8	12	9.15	805	11.5	9200	27.9
" 145lb	"	"	"	"	"	"	"	"
Intermed.	11	8	16	9.06	798	11.2	8900	27.0
Assoc.	13	8	0	9.38	825	12.0	9900	30.0
Senior	14	7	43	9.72	855	12.9	10900	33.0
" 145lb	5	7	37	9.84	866	13.1	11300	34.2
DISTANCE 1⅝ MILES*								
2nd Single	4	8	48	9.98	877	11.8	9600	29.1
1st "	4	8	50	9.26	815	11.7	9500	28.8

X 1923 and 1926
Y 1926 Strong head wind
Z 1923 to 1926 Inc.

FIGURE 1

ous leg requirements—to which the oarsman's feet are secured, and the sliding seat, developed in 1870 by G. C. Babcock, Nassau Boat Club, New York, which adds the leg drive to the body swing of the fixed seat, thus providing a very satisfactory means for effectively applying all the oarsman's power. The seats are fitted with rollers of an almost frictionless type, placed on tracks which limit the travel of the seat to a fore and aft direction. The tracks are of suitable length to meet the leg-drive requirements.

The modern racing shell is therefore a highly developed racing device with high propulsive efficiency and a corresponding high racing speed.

THERE has been considerable discussion on the characteristics of a hull of least resistance with a view to increasing racing speeds. Hull characteristics in relation to resistance is a subject which has interested the navy departments of many governments in the design of naval vessels and shipbuilders in the design of merchant ships. An early method was to tow a model and measure the resistances corresponding to different speeds, but such a method was subject to errors in observing tide, wind, distance, and time of run. Also, favorable weather conditions could not always be had. The need for laboratory facilities for studying the many problems of hull form, resistance, propulsive requirements, and so on became more and more apparent and in time, model basins were built. There are two in this country, one at the Washington Navy Yard, and the other at the University of Michigan.

The determination of the resistance of an eight-oared shell with its crew by the towing method was reported by Professor Yandell Henderson in the article, "The Maximum of Human Power and Its Fuel," April 1925, *The American Journal of Physiology*. However, since those determinations were reported, tests have been made at the model basin at Washington Navy Yard on several single and eight-oared shells. We will briefly review the method of conducting the tests and the equipment employed.

The model basin consists of a tank about 470 feet long, about 42 feet wide, and about 14 feet deep, filled with water. Over it is placed a building arranged to be heated, lighted and ventilated. Tracks located on each side of the tank and extending its full length, support a carriage on which is placed the electrical control equipment to regulate carriage speeds up to 20 knots. There are also instruments on the carriage for determining and recording the experimental data, including one attached to the model under test which registers the resistances corresponding to the various speeds of the model through the water.

The tests of six single shells of different models gave results so nearly alike that the relation between resistance in pounds and speed in miles per hour may be represented by the R-V curve in Figure 3. A curve showing the relation between the work done in foot pounds per minute and speed in miles per hour derived from the R-V curve is the P-V curve of the figure.

The tests of the two eight-oared shells are similarly represented by Figure 4. The curves of Figures 3 and 4 are plotted on cartesian co-ordinates, and those curves are reproduced plotted logarithmically in Figure 5, from which the following exponential equations showing the relation between resistance and power based on speed were deduced:

$$\text{Eq (1)} \quad R_s = .158\ V_s^{1.935}$$

$$(2) \quad R_8 = .557\ V_8^{2.012}$$

$$(3) \quad P_s = 15.8\ V_s^{2.875}$$

$$(4) \quad P_8 = 55.6\ V_8^{2.956}$$

In which:—

R_s = Resistance of single shell in pounds.

R_8 = Resistance of eight-oar shell in pounds.

P_s = Work done in overcoming resistance R_s in foot-pounds per minute.

P_8 = Work done in overcoming resistance R_8 in foot-pounds per minute.

Eq (1) and (2) may be expressed approximately R varies as V^2

Eq (3) and (4) may be expressed approximately P varies as V^3

WE note by the last expression that the power required to increase the speed of a shell by even small amounts at the usual racing speeds is very large.

In order to apply most satisfactorily the curves of Figures 3, 4 and 5 to racing conditions to determine the work done by a crew, it is essential that the races be rowed in still water, that is, water with no current, and a wind velocity or zero, conditions which

WORK DONE BY AN 8-OAR SHELL CREW
ON
SCHUYLKILL RIVER COURSE, PHILA, PA.
REGATTAS
1922 TO 1926 INCLUSIVE

Event	No. Races	Time Min.	Time Sec.	Miles per Hour	Feet per Min.	Resistance lbs.	Ft-lbs per Min.	Ft-lbs per Man	% Horsepower
DISTANCE 1 MILE*									
Junior	2	5	38	10.66	938	64.8	60800	7600	23.0
Intermed	2	5	39	10.62	935	64.2	60100	7510	22.8
Senior	2	5	14	11.47	1009	74.8	75400	9430	28.6
DISTANCE 1¼ MILES									
Junior	13	6	41	11.33	988	71.9	71000	8880	26.9
Intermed	8	6	37	11.35	998	73.5	73300	9150	27.7
Senior	10	6	32	11.49	1011	75.1	76000	9500	28.8
" 145lb*	1	6	49	11.01	969	69.0	66700	8340	25.2
DISTANCE 1⅝ MILES*									
Senior	3	7	15	10.72	952	66.7	63400	7930	24.0

X 1923 and 1926
Y 1926
Z 1924 to 1925 Inclusive

FIGURE 2

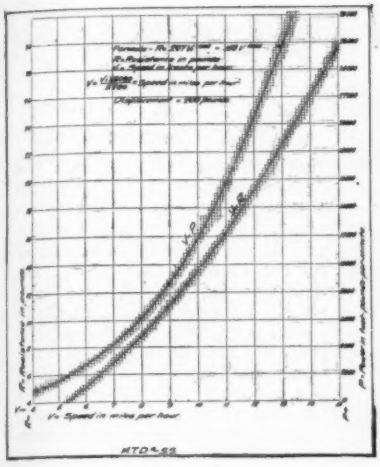


FIGURE 3

are difficult to obtain because most of the regattas are held on rivers.

The regattas held on the Schuylkill River, Philadelphia, for non-college crews are for courses of $1^5/_{16}$, $1\frac{1}{4}$, 1, and $\frac{1}{4}$ mile distances.

The data of these regattas have been compiled for junior, intermediate, association and senior single scullers in Figure 1, and for junior, intermediate and senior eight-oared shell crews in Figure 2. The data for the $1^5/_{16}$-mile course is based on four, the $1\frac{1}{4}$-mile course on 14, and the 1-mile course on two regattas. The speeds given in the figures were computed from the elapsed times between the firing of the starting gun and the finishing gun. The shells are held at the starting buoys to await the starting gun.

The river current varies from almost still water during a drouth to quite rapid after a heavy rainfall, and the wind from zero velocity to quite strong either up, down or across the course. The number of races used to compute the mean time is given in Figures 1 and 2. The data of the $1\frac{1}{4}$-mile course are considered to be the most satisfactory because a greater number of regatta conditions are represented and the oarsmen are probably in the best condition for racing. The American Henley Regatta occurs before the oarsmen have had sufficient time to be thoroughly trained, and the Labor Day Regatta, which closes the rowing season, finds the oarsmen somewhat stale.

WE therefore do not find an increase in the average velocity as the course is shortened from $1^5/_{16}$ miles to 1 mile, so we cannot plot a curve showing the effect of fatigue on speed for the several distances. It is interesting to note, Figures 1 and 2, that the work done by a single sculler and per man in an eight-oared shell crew for the same length course is approximately the same, indicating that the oarsman under the stress of contest gives all the energy he has to expend in the endeavor to win, and that the single sculler expends about $\frac{1}{2}$ horsepower per minute during the quarter-mile dash.

No attempt has been made to compile data on college eight-oared shell crews and apply them to Figures 3, 4 and 5, but their speeds are faster than the non-college crews and the power expenditure would be correspondingly greater as indicated by the expression "P varies as V3."

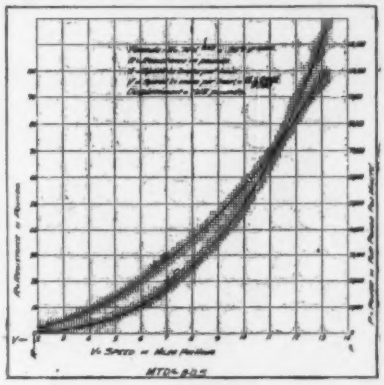


FIGURE 4

We may some day be able to determine the velocity of racing shell by means of a Pitot tube and an autographic recording-mechanism similar in principle to installations which have been made on some of our ships. This experimental apparatus should provide a record of the velocity of the shell during the first portion of the race, the slowing down afterward, and the sprint just before the finish, also the velocity changes during the pull and recovery periods of the stroke, and by this means enable us to accurately analyze the power expended by an oarsman.

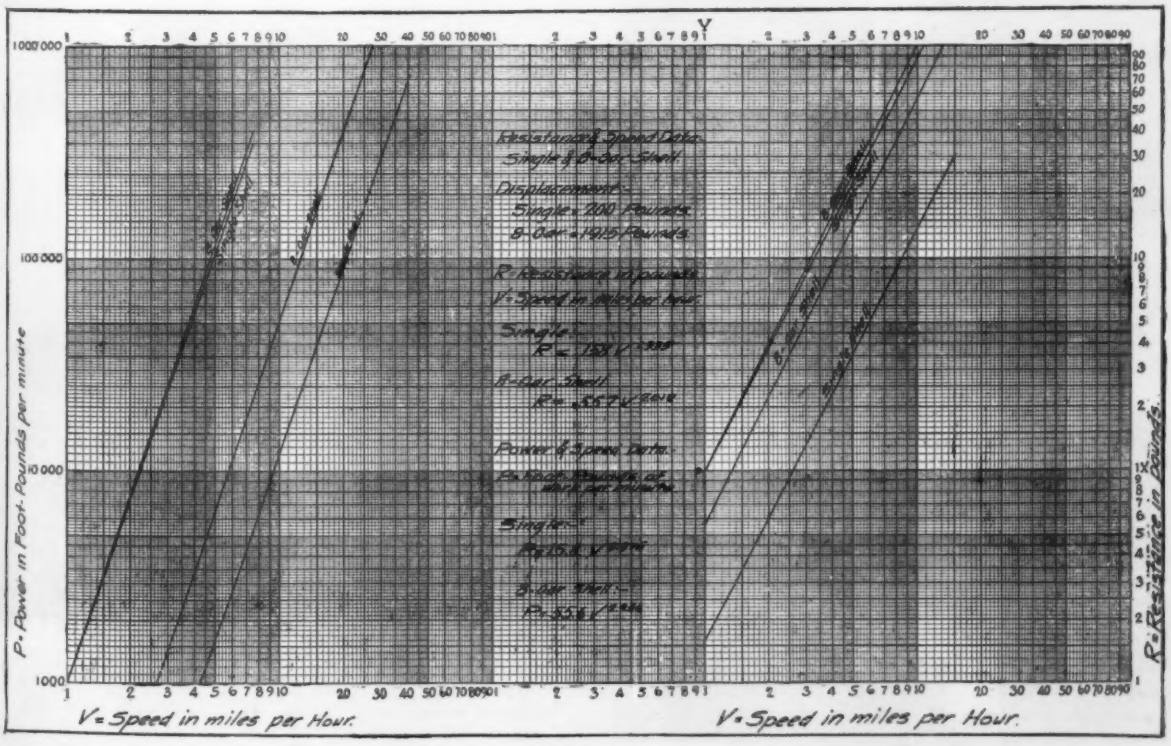
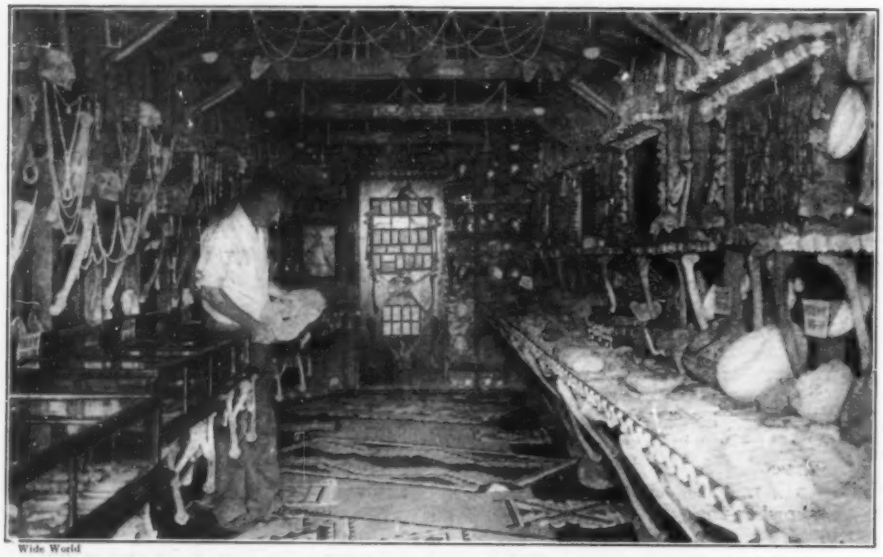


FIGURE 5

From the Scrap-book of Science—



Wide World

AMATEUR ARCHEOLOGY

Ralph Glidden of California has made a large collection of Indian bones, pottery and stone implements dug from the soil of Catalina and others of the Channel Islands off the coast of that state. His collection is neatly housed in a private museum which seems to be rather compactly furnished with these objects. During the past few years public interest in archeology has increased very greatly and a number of amateurs, often self-trained, have done excellent scientific work of that kind. Increased attention has been given to American archeology, and SCIENTIFIC AMERICAN readers may often help the work by keeping watch of local excavations and reporting to science any finds that they may make

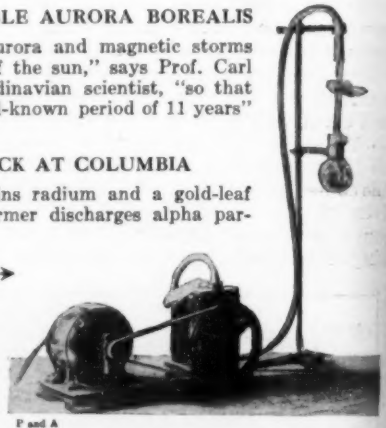
P and A

THE INCOMPARABLE AURORA BOREALIS

"The frequency of aurora and magnetic storms follows the activity of the sun," says Prof. Carl Stormer, noted Scandinavian scientist, "so that all three show the well-known period of 11 years" ◄

RADIUM CLOCK AT COLUMBIA

The glass bulb contains radium and a gold-leaf electroscope. The former discharges alpha particles at uniform intervals determined by the pressure, discharging the leaf every few seconds ►



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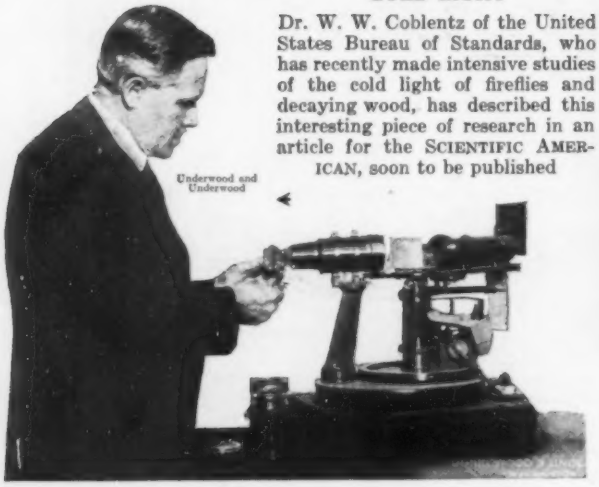
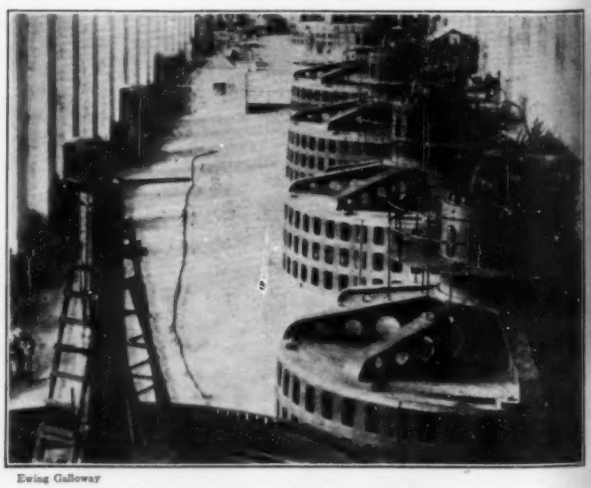


Underwood and Underwood

COLD LIGHT

Dr. W. W. Coblentz of the United States Bureau of Standards, who has recently made intensive studies of the cold light of fireflies and decaying wood, has described this interesting piece of research in an article for the SCIENTIFIC AMERICAN, soon to be published ◄



Ewing Galloway

GENERATORS AT MUSSEL SHOALS

When an engineering job gets into politics, it is liable to assume undue proportions. Mussel Shoals is a big project but not as big as the volume of talk it has occasioned in Congress, in the newspapers and elsewhere

Camera Shots of Scientific Events

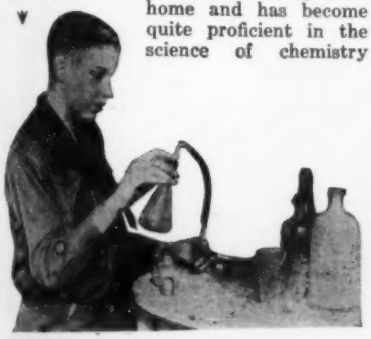
BIG NEW DAM

Two miles below Conowingo, Maryland, work is steadily progressing on the huge, mile-long dam which is to supply hydro-electric power to the city of Philadelphia. When completed it will be second in power capacity only to the Niagara Falls power plants. To construct the dam will require 650,000 cubic yards of concrete. The lake formed in the valley of the Susquehanna River will be 14 miles long. The initial power supplied by the new dam, which will be completed in the autumn of 1928, will be 378,000 horsepower. In time this will be increased to 594,000 horsepower, which would make it the largest hydro-electric power plant in the United States or Canada

Wide World

BLIND SCOUT CHEMIST

Clifford Walker, thirteen, of Atlanta, Georgia, who recently passed the exacting tests required to qualify as a Scout of the First Class, has a chemical laboratory in his home and has become quite proficient in the science of chemistry



P and A

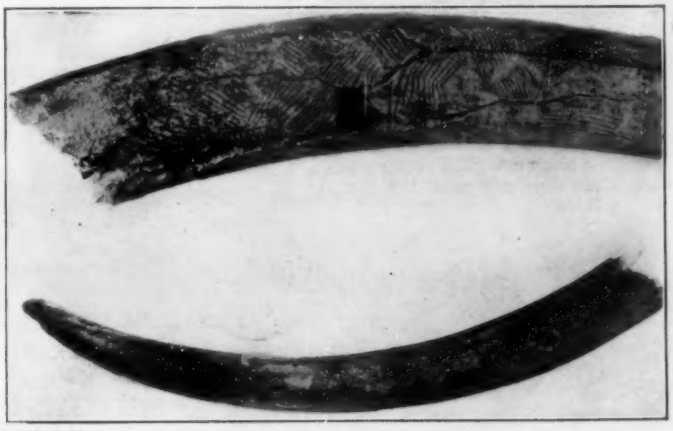
MERMEN

Spécial life - saving suits have been issued to some of the harbor firemen of Los Angeles to help them in their work which often requires that they get into the water; sometimes they accidentally fall into it. Suits of this kind keep them dry and warm so that they do not have to stop work or run the risk of serious illness due to exposure

Underwood and Underwood

LIVING FOSSIL BIRD

A "living fossil" in the shape of a bird from Madagascar has recently been given to the Smithsonian Institution by Mr. B. H. Swales, of its staff. The bird is the mesite, called also the roatelo, a curious archaic species with no near living relatives, seemingly a survival of earlier periods in the age of the earth which has hung on long after its contemporaries have become extinct. The hoazin is another "living fossil" bird

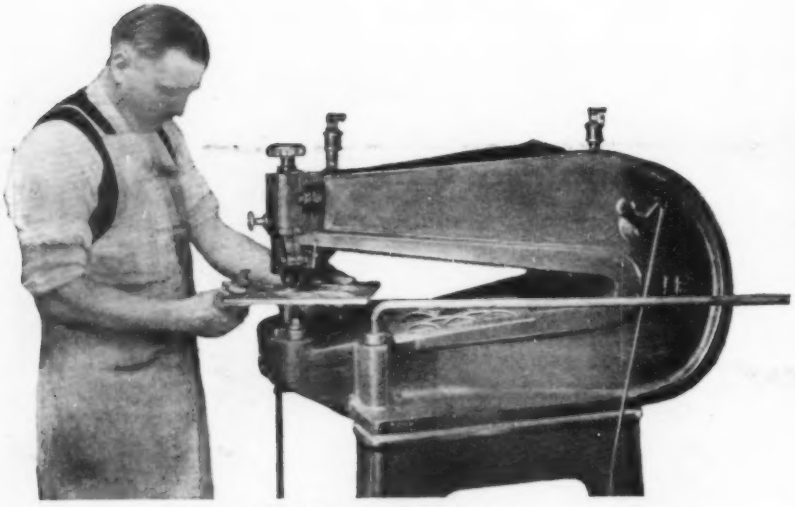


Wide World

MAMMOTH'S TUSKS CARVED BY ANCIENT MAN

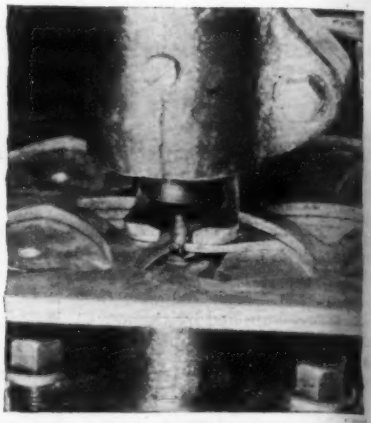
Recently in Czechoslovakia, archeologists discovered a great "cemetery" of mammoths. The bones of many of these extinct elephants were found on a bed of ashes, indicating that prehistoric man had feasted on mammoth meat. The carved tusks shown belong to the early part of the Cro-Magnon period, 20,000 years ago

Inventions New and Interesting



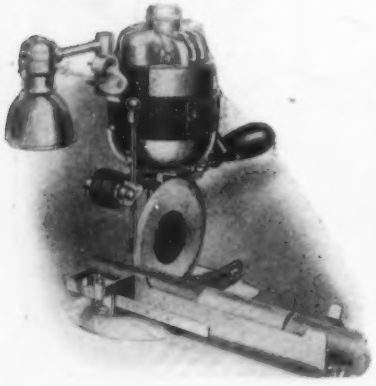
"NIBBLING" SHEET METAL

The newly developed machine illustrated above is designed for cutting intricate parts from sheet metal, bakelite and the like. It does away with the old method of drilling the pattern and then grinding to the line. The operator of the machine can govern the direction of the cutting while the mechanism is working



THE CUTTING TOOL

A close-up view of the cutter that is employed in the "nibbling" machine illustrated at the left. The work is guided under the reciprocating cutter



BANDAGE CUTTER

Bandages are made in long rolls and then cut to the required length. The machine illustrated above performs the cutting in a sanitary way and makes a clean cut. The sharp rotating blade does not ravel the gauze

SAFETY STRAP

Men working on horizontal pipes, painting or repairing them, are likely to slip off, with disastrous results. To prevent such happenings, the safety strap illustrated above is in use at the plants of the Ford Motor Company. A circular belt surrounds the pipe and fastens to the belt around the man's waist. It will hold the man suspended until assistance arrives

ELECTRIC TRUCK

This small yet powerful truck can be loaded easily and, because of its construction, it can be steered rapidly about a shop without any difficulty

WHEELBARROW

The tray of this wheelbarrow is demountable, allowing the use of any one of 13 different trays, according to the job to be done. A novel arrangement holds the tray firmly in place

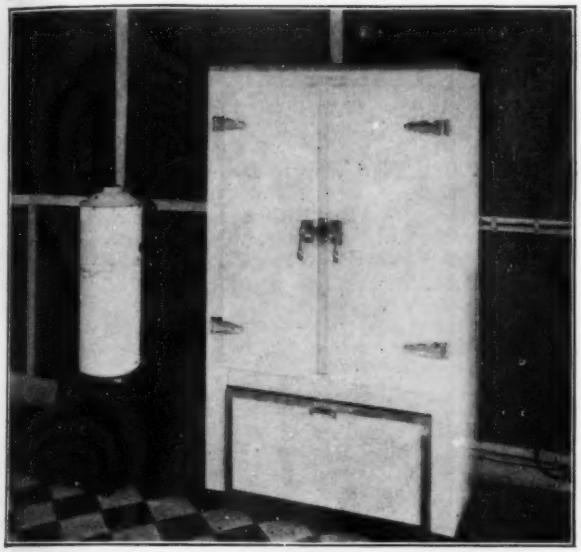
A REAL "PEN-KNIFE"

This combination fountain pen and small knife will find many uses when carried by anyone requiring the aid of either of the illustrated units. Both are well built and serviceable

Household Inventions

Iceless Refrigerators Are the Latest Boon to Housewives

CONDUCTED BY ALBERT A. HOPKINS

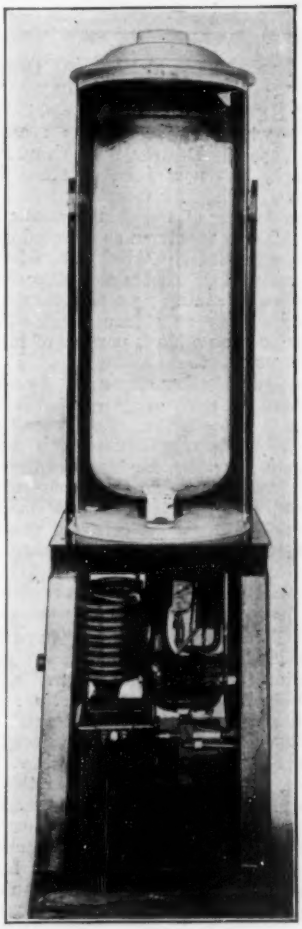


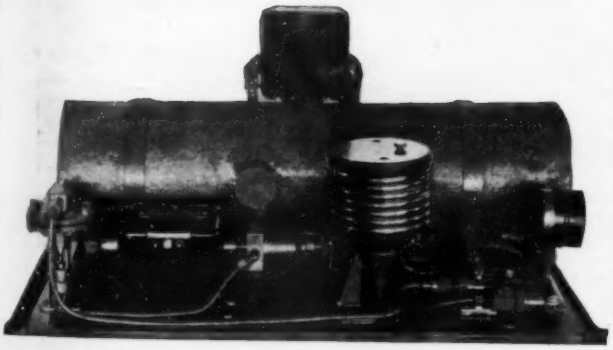
SILENT ICEMAN

"Silent as the Arctic" would be a good slogan for this iceless refrigerator in which no power machinery is used. It is operated by gas which serves to actuate a dry absorption process, circulating the refrigerant by heat. Oiling and cleaning of machinery is thus eliminated

HEAT FOR COLD

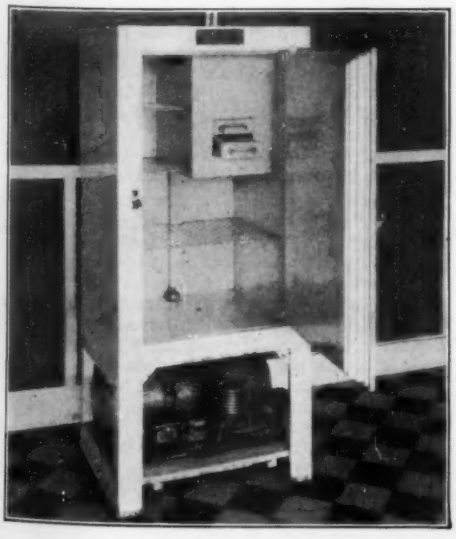
The operation of this device depends on the use of a special dry absorbent material with a great affinity for ammonia gas, which it will hold in storage as long as it remains cool. When heated distillation takes place, ammonia gas is driven out, condensed to liquid and evaporated during the freezing cycle





ICE BY WIRE

The absorption system can be operated by electric heat as well as gas heat; the principle is the same. Electricity is available in many places where there is no gas supply and the results are equally dependable. During the change of state of the ammonia from liquid to gas, heat is absorbed from the surrounding materials and carried away by the ammonia gas

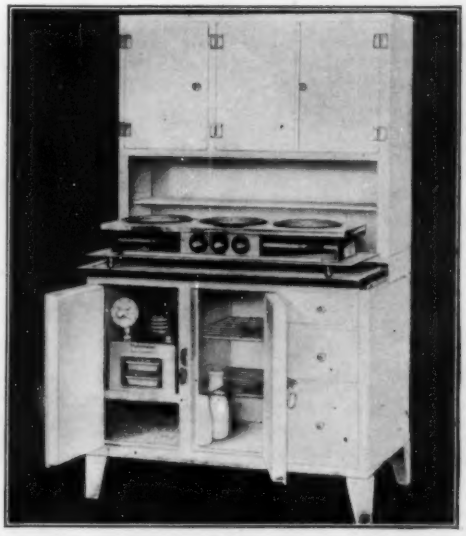


FOOD PRESERVER

Those who have ever had a household refrigerating plant will never return to ice. The food is so much better preserved that the purchase expense is soon absorbed by the saving in food. Handy little ice cubes also are made for beverage purposes

THREE IN ONE

Here we have a great kitchen trinity — kitchen cabinet, electric stove and electric refrigerator. A gas stove may be substituted for the electric stove. Everything is so well insulated that the electric refrigerator functions without being affected by the heat being generated in the stove above



The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS

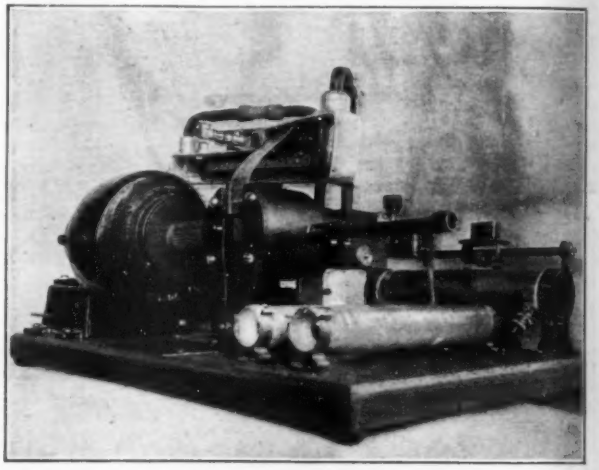
New Chemical Element Obtained in Pure Form

RHENIUM, the chemical element whose discovery was recently announced by Doctors Walter and Ida Noddack, has now been obtained in pure form. The first discovery was based on the finding of the characteristic lines in the X-ray spectrum as detected by photographic plates. Now the Noddacks have succeeded in obtaining, after long and difficult refining processes, a small quantity of the substance itself. They describe it as a black powder of high melting-point, that unites readily with a number of other elements. In an atmosphere of pure oxygen it ignites, forming a white oxide. The quantity so far obtained is very minute, only two milligrams, or seven one-hundred thousandths of an ounce. The experimenters are now at work to elaborate more of it which will permit of exact quantitative chemical examination.—*Science Service.*

Anti-Evolution Legislators Hail from Backward Counties

"IT has been observed," says Dr. Roland M. Harper, well-known Southern botanist and sociologist, writing in the *Daily Science News Bulletin*, "that the authors and supporters of anti-evolution bills which have been introduced in several state legislatures in the last few years (and passed in two or three) generally hail from some of the more "backward" counties; and on the assumption that such legislators reflect the views of their constituents, the writer has made a statistical study of the population of such counties in 14 states, ranging from Delaware to Florida, North Dakota and California. In some states, two or three counties are involved, on account of anti-evolution bills having been sponsored by two or more members, or in different years. The statistics are based on the white population only, for other races are not known to have taken any part in the controversy.

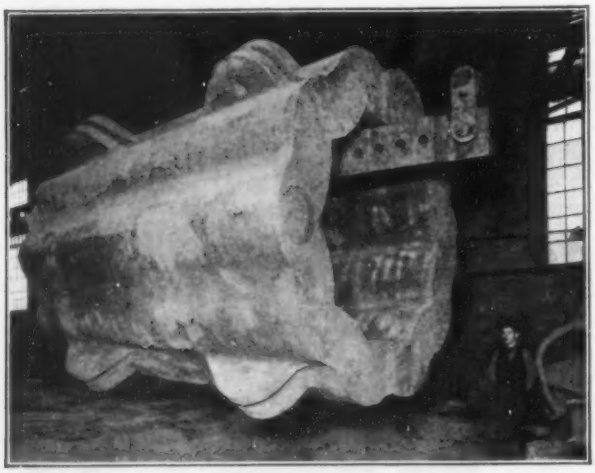
"It is found that the anti-evolution counties, taken together, rank below the combined averages of the same states, and still more below the United States average. For instance, the 1920 illiteracy figures for adult whites in Tennessee are 9 percent for the state as a whole, but 26.6 percent for Macon county, the home of the author of the law that started the famous Dayton trial."



Mr. Nordlander's new mercury-vapor detector. Selenium sulfide applied to paper, blackens when exposed to the fumes. The apparatus draws a strip of this paper over an opening through which air flows. Light shines through the paper strip in amounts depending on the blackening, and reaches a photo-electric cell. The detector is then read directly from an ammeter

387,590 Pounds Heavy

THE Bethlehem Steel Company, at its Bethlehem, Pennsylvania, plant, has just completed an extraordinarily large ingot-mould for casting ingots which will be used in making large forgings. This casting, as poured, weighed 387,590 pounds. The length of the casting is 15½ feet; its width measured across the corrugations at the top of the mould is nine feet. The ingot produced from this mould, a picture of which appears in these columns, will weigh 247 tons.



A mammoth casting made in Bethlehem, Pennsylvania. It is a mould in which ingots will later be cast. Its overall size may be noted by comparison with the figure of a workman who may be seen standing to the right of it. Internally it is large enough to hold a cast ingot which will weigh 484,000 pounds. Alone its weight is 387,590 pounds

New Way to Detect Poison Mercury-Vapor in the Air

MERCURY is from many viewpoints a very interesting substance. Its most distinctive property perhaps is that it is the only metal which is liquid at room temperature, says Birger W. Nordlander of the Research Laboratory of the General Electric Company at Schenectady, New York, the inventor of a new method of detecting poison mercury-vapor in the air. "Even at this temperature it has a noticeable vapor pressure which rapidly increases with the temperature. Owing to this, vapor will constantly be given off from the metal and evaporate into the room where the metal is confined. If, therefore, mercury is spilled out on the floor or left in open dishes, there will always be a certain amount of mercury vapor in the air of the room. Even in high concentration the vapor has no color or odor, therefore it cannot be distinguished by the senses.

"Another interesting property of mercury," continues Mr. Nordlander, "is that it combines readily with most metals to form amalgams, of which those with silver are extensively used as fillings in dentistry. The incandescent vapor of mercury is rich in ultra-violet rays which have found wide use in therapy. Mercury has a remarkable combining power with organic substances like proteins, albuminoids, and fats. Closely related to this property is the physiological fact that the metal and most of its compounds are toxic poison.

"Due to the specific properties of mercury and its compounds, they have found many uses in the industries, such as amalgamation, electro-chemical manufacturing processes, explosive manufacture, catalysis, medicine, dentistry, electrical

apparatus, (such as rectifiers and lamps), manufacture of certain dyes, wool and fur dyeing, carotting of fur, etching of metals, heating operations, in physico-chemical apparatus like pumps, barometers, thermometers, et cetera.

"The recent development of the mercury-vapor process for generation of power, by which a considerable improvement in fuel economy is made possible, has opened up a new field for the use of mercury, which, if extensively applied, would require perhaps five million pounds per year. [Note: Mr. Nordlander here refers to Dr. Emmet's mercury-vapor boiler and turbine unit which is installed at Hartford, Connecticut, where it develops at high efficiency 10,000 kilowatts of energy. A drawing of this interesting unit is reproduced in these columns.—the Editor.] This would necessitate increasing by 70 percent the present world production and would therefore by far outweigh any other application of mercury in importance. For a safe and economical operation of this process, it is necessary that there should be no leakage, since mercury is both poisonous and costly.

"Although the possibility of mercury escaping into the boiler room is practically eliminated by a special design in which all parts containing mercury are enclosed either in the flue or in a housing through which the air for combustion is drawn, thus insuring the discharge of any leaking vapor outside of the building, nevertheless, it was realized that the public demand for safety would require a method by which a constant watch and recording of the mercury-vapor content of the air in the boiler room could be made. It was also of utmost importance to be able to get a continuous record of the mercury-vapor content in the flue gases.

"None of the existing methods were applicable since they all are cumbersome and demand considerable time and skill. Research was therefore undertaken which has resulted in a new indicator of extremely high sensitivity for mercury vapor, and a method has been developed which gives quick results and does not require chemical training to carry out.

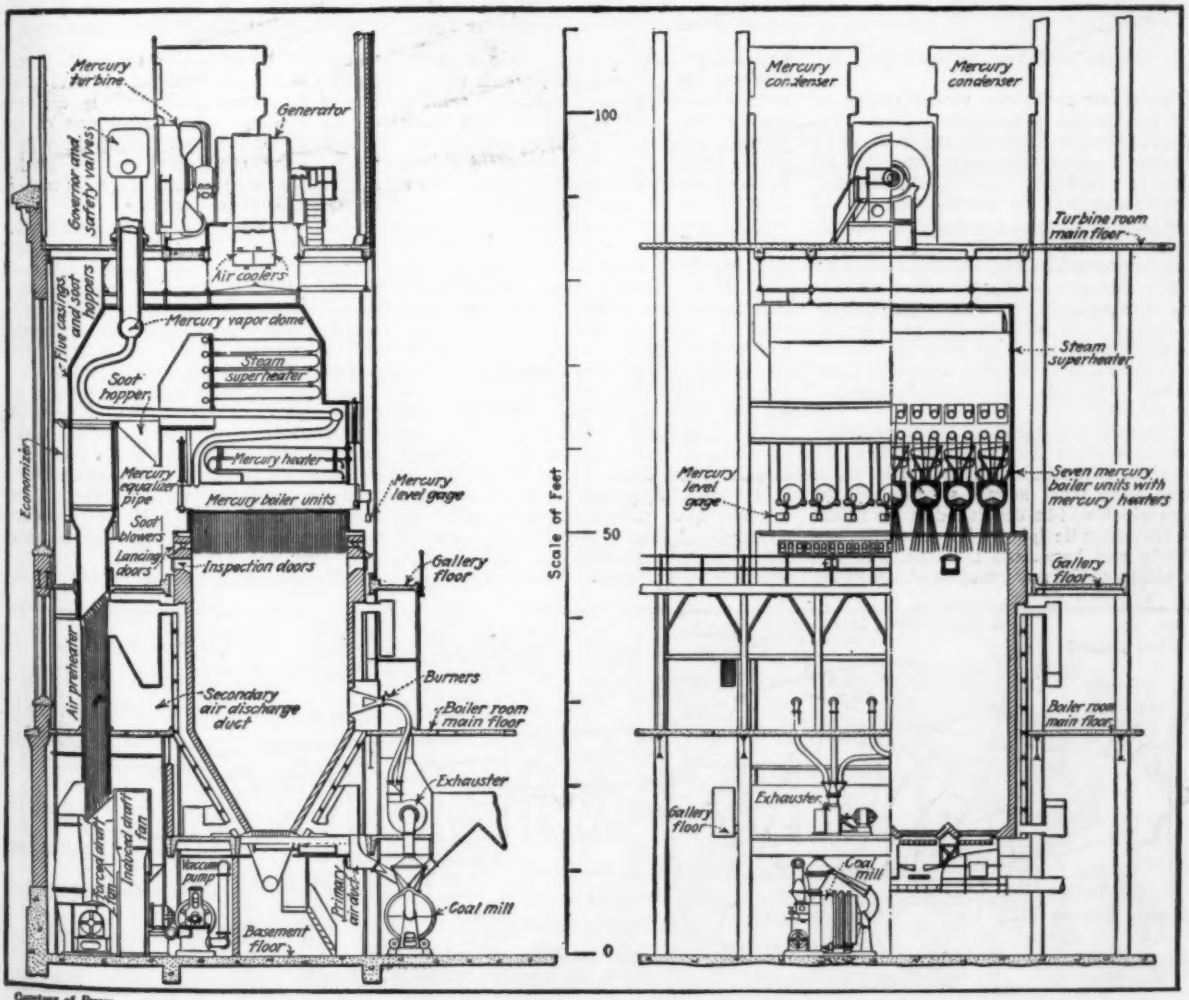
"Briefly, it was found that mercury vapor would react with freshly melted and cooled sulfur to form the black sulfide. This sulfur showed a fair sensitivity which, however, disappeared entirely after a few days. It was evident from this that the reactivity was confined to one of the unstable forms of the element. It developed that this active form could be stabilized by combining it with selenium, an element closely resembling sulfur, and ultimately it was found that a compound of the two, with the chemical formula SeS_2, selenium sulfide, possessed the highest sensitivity to mercury vapor, being about 200 times as sensitive as the most active sulfur.

"On exposure to air containing mercury vapor, paper coated with this chemical is blackened, due to the formation of the mercuric sulfide and selenide. It is possible to use this relationship to make up a color scale for the quantitative estimation of mercury vapor, and by which almost any concentration can be determined. For reasons in connection with the testing of the flue gases from the mercury boiler, a temperature of 70 degrees, Centigrade, and a velocity of one meter per second have been chosen as standard conditions for the test. The sensitivity of the indicator under these conditions is such that by changing the time of exposure anywhere from eight minutes to one minute, any concentration between 1 in 8,000,000 to around 1 in 15,000 (by volume) can be estimated by comparison with the standard color chart.

"A portable apparatus has been worked out by which the standard conditions of the test can be maintained constant. By means of this, it is now possible to determine the mercury-vapor concentration in any desired locality. The operation of the apparatus is extremely simple and does not require any training or skill. For a continuous and automatic registration of the vapor content, a type has been developed by which a record for a whole day can be obtained.

"The latter type of apparatus has been installed at a commercial installation of the

(*Continued on page* 266)



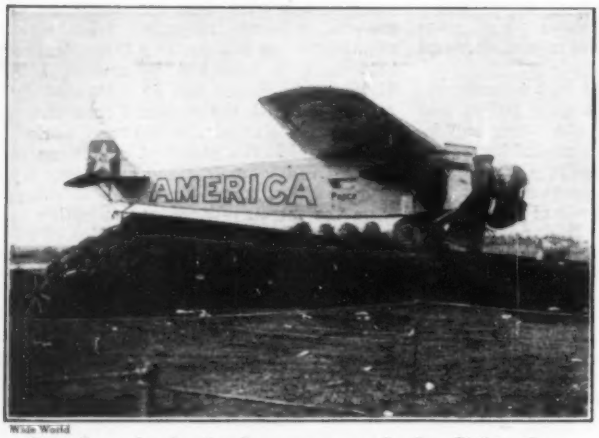
Courtesy of Power

The Emmet mercury-vapor plant installed by the Hartford Electric Light Company. In place of water vapor or steam, mercury vapor generates the power. This successful plant has a capacity of 13,500 horsepower

Learning To Use Our Wings

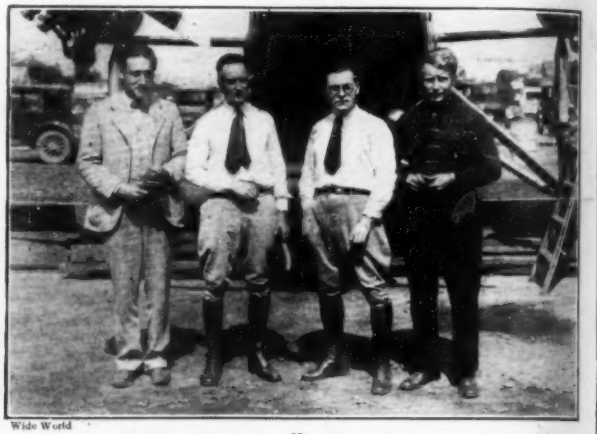
This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University



Wide World

Poised on its inclined runway, ready for flight, the "America" waited the advent of propitious weather



Wide World

The crew of the "America." Left to right: Acosta, Commander Byrd, Noville and Balchen of Norwegian navy

Byrd and the "America"

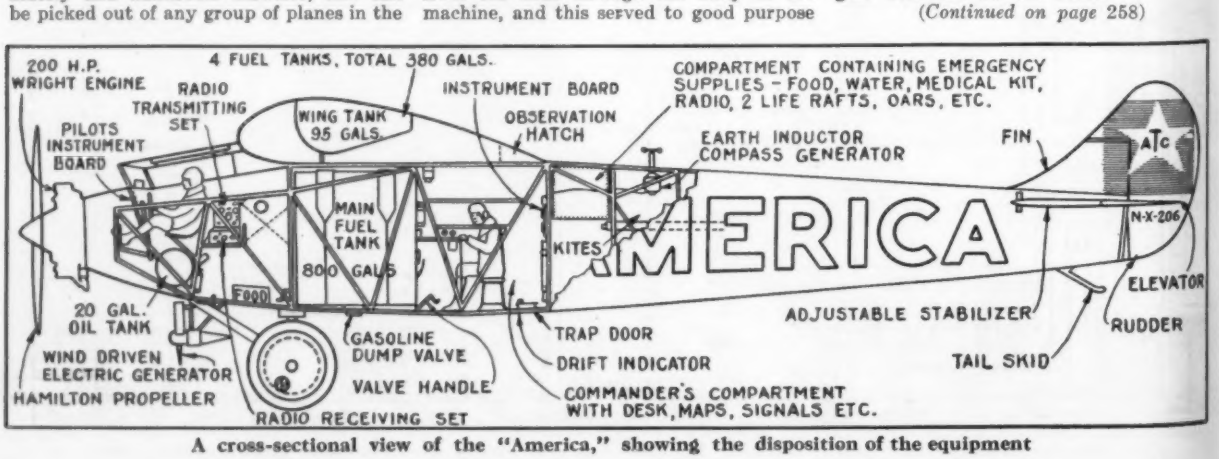
EACH of the three recent flights to Europe has its own special distinction. That of Lindbergh stands out preeminently because he went absolutely alone, and hit his objective, Paris, "squarely on the nose." Chamberlin will be remembered as the first man to carry a passenger to Europe and, at the same time to break the long-distance record. Long before he made his flight, Commander Byrd claimed that he was seeking scientific results, particularly in regard to weather conditions over the Atlantic, and there is no doubt he brought back with him to America data which will be helpful to transatlantic air voyagers of the future.

It is safe to say that, of the three planes that have made the transatlantic trip, the big three-engined Fokker monoplane which Byrd used most nearly approached the type which will be developed in the future for transatlantic flying. The *America* is a stately and handsome machine, and can be picked out of any group of planes in the air, because of its remarkable stability fore and aft and laterally, which the big Fokker monoplanes invariably exhibit. Another excellent feature is that these planes are aerodynamically so perfectly designed that they have an inherent ability to straighten out instead of falling into a nose dive when the ship approaches the stalling speed. On looking at the longitudinal section of the plane, one is struck with the great depth of the wing and its very blunt forward edge. Wind-tunnel experiments have shown that this is a most efficient wing for any but high racing speeds and it is a well-proved fact that in a wing of this type, only 25 to 30 percent of the lift of the wing is due to air pressure against its lower surface, and the other 70 to 75 percent is due to the negative air pressure, or suction, as it is popularly called, on the upper side of the wing.

The graceful appearance of the *America* has not been gained at any sacrifice of strength. A stout metal truss extends from the nose through the body of the machine, and this served to good purpose when the heavy plane made its forced landing in the sea, under the skillful handling of Lieutenant Balchen. In the nose of the fuselage is mounted one of the famous 200-horsepower, air-cooled Wright engines—the other two engines of the same make being carried in special mounts on each side of the fuselage.

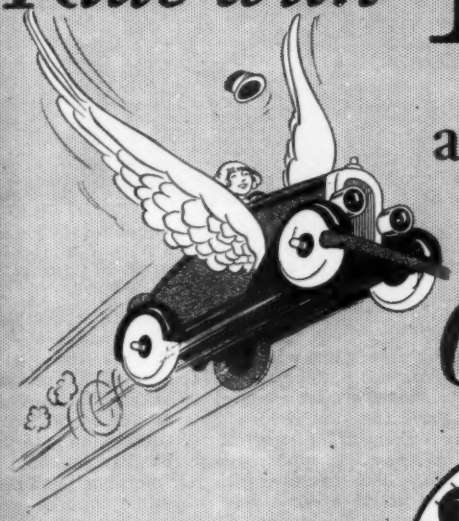
Our line drawing, for which we are indebted to the *Aero Digest*, is so complete that there is no necessity to elaborate upon the data there given. We draw attention to the large main fuel tank, which can be emptied and then tightly closed, thereby affording large additional buoyancy in the event of forced descent upon the sea. Note also the radio transmitting and receiving sets in the forward compartment; the spacious commander's compartment immediately behind the main fuel tank; and the all-important generator and earth inductor compass which served Commander Byrd so well until, for some unaccountable reason, it was thrown out of gear over the French coast.

(*Continued on page* 258)



A cross-sectional view of the "America," showing the disposition of the equipment

Ride with ETHYL



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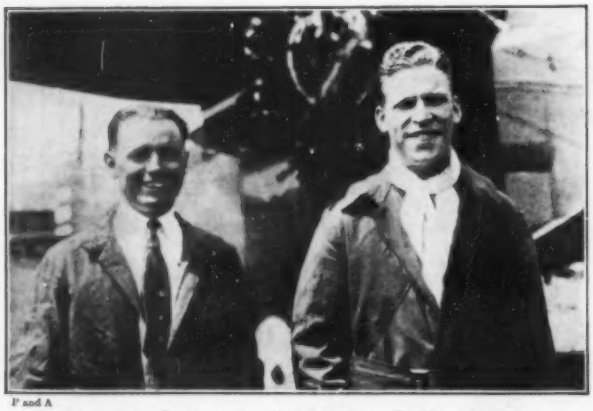
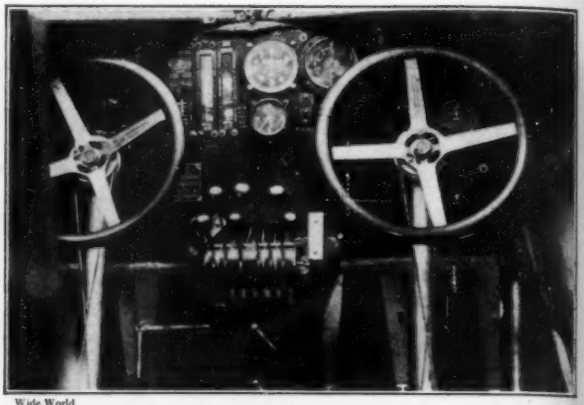


P and A

Lieutenants Lester J. Maitland and Albert Hegenberger who flew a three-motored Fokker monoplane from California to Wheeler Field, Honolulu, Hawaii



Wide World

The dual controls in the Fokker monoplane that made the Hawaii flight. Each pilot has a view of the instruments and has his own controls of the plane

Commander Byrd's articles descriptive of his flight, which appeared in the public press, are so complete and clear that it is sufficient, just here, to touch only on some of the outstanding features. He was in the air for a total of 43 hours, during which he estimates that the *America* traveled about 4200 miles. Of the three recent trips, it is evident that, so far as weather conditions are concerned, the *America* had the most difficult and strenuous time. The trip from New York to Newfoundland was made under rather trying conditions. Byrd had scarcely left Newfoundland before he ran into the prevailing fogs above the Newfoundland banks, and he tells us that for 19 hours of his transatlantic passage he had no sight either of land or of water, being completely surrounded by dense, impenetrable fog.

Acting on the meteorlogical data furnished by the Weather Bureau, he rose to a height of 10,000 feet in order to get above the fog banks and the clouds and veered somewhat from his intended course so as to avoid the storm and secure the advantage of a favorable wind upon its outer fringe. The wind seemed to have been with him during a large part of his trip above the Atlantic. He steered for Finisterre and was successful in making it; but here he ran into extremely bad weather, dense clouds, fogs and heavy rainstorms, and at this critical moment his best friend, the earth inductor compass, failed to function.

He believes that he reached Paris; but so thick was the weather that he had no sight even of the powerful searchlights or of the rockets which were sent up from the Bourget field to aid him. He was over Paris with sufficient fuel for another 300 miles of travel, but in his graphic story in the *New York Times*, he says, "We must have been near Paris twice in the five hours of venturing, in pitch darkness, with the rain pouring." At this point, with the young Norwegian flyer, Balchen, at the wheel, he decided to return to the coast and take the least risk of landing upon the water. This he did near the little village of Ver-sur-Mer, where, guided by the flash of the lighhouse, Balchen brought the ship down. The landing gear was stripped as it struck the water 200 feet from the beach, but the four men, Commander Byrd, Noville, Acosta and Balchen reached shore by inflating the emergency raft and sustained no more serious injuries than shock, bruises, and in the case of Acosta, a fractured shoulder blade.

The Flight to Honolulu

ALTHOUGH an airplane flight from San Francisco to Honolulu does not compare either in distance or difficulty with a flight from New York to Paris, the recent exploit of the two army officers, Lieutenants Maitland and Hegenberger, is a highly meritorious performance. The distance covered was 2300 miles as against about 3600 miles to Paris, and the weather was certainly more propitious than that encountered by the transatlantic flyers. The plane used was a tri-motored Fokker monoplane, practically identical with that used by Commander Byrd.

There was one respect, however, in which these army flyers were confronted with a far more perilous and perplexing task than that of flying the Atlantic. We refer to the fact that the group of Hawaiian Islands covers so little space in a north and south direction, or normal to the line of flight, that on the map it looks not much larger than the head of a pin. Hence, whereas the Atlantic flyers had a thousand-mile stretch of continent to aim at, the transpacific flyers must hit a baseline a few miles in extent or, missing the islands, drive fruitlessly into the unknown wastes of the Pacific, until they fall exhausted into the sea. As it turned out, the navigation was magnificent, and our gallant fliers struck the islands "squarely on the nose."

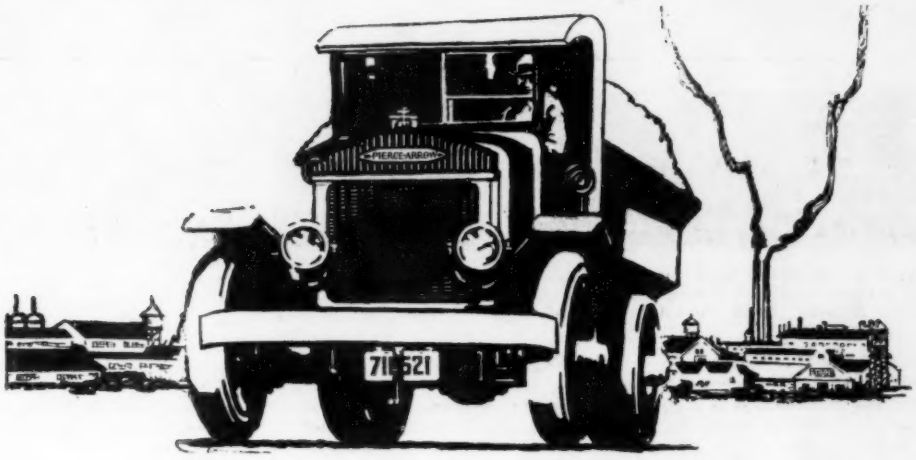
With that admirable modesty which, it seems, invariably characterizes the officer personnel of our army, these young lieutenants attributed their success to the splendid army organization and the great care with which the equipment, both of the machine itself and of the aids to navigation, was prepared before the start was made.

The story of the flight, as so admirably told by the fliers, Maitland and Hegenberger, in the *New York Times*, is replete with interest and rich in technical data. The Fokker monoplane, specially strengthened as the result of preliminary tests, weighed empty 6600 pounds, and 14,000 pounds as it left the ground. It is explained that the flight was decided upon long before any prizes were offered for such a flight. The venture was a strictly military one, and had as its objective the linking of the mainland with our island territory. Of particular importance was the new radio beacon, one of which was erected at San Francisco, and the other on the island of Maui. These beacons were to signal the course; the flyers catching the signals would be able to check their position relative to the direct course as laid out.

The heavily-loaded plane left the ground after a run of about 3200 feet and passed the Golden Gate at a level of 2000 feet. The method of determining drift by dropping smoke bombs was abandoned because, with the morning light in their eyes, it was impossible to take accurate sights; instead use was made of the spume left on the water by passing waves, which was sighted through the floor of the cockpit. The radio-beacon signals were picked up, and proved that they were on their course, but after they had been out one hour, the signals ceased, and at the same time, the important inductor compass failed to function. Then clouds were encountered, and in order to obtain drift measurements through observation of the sea surface, it was necessary to drop down from about 3000 feet to 300 feet, at which level they flew for the rest of the day. Another attempt was made with smoke bombs, but the air was "bumpy" and the tail of the plane waved to such an extent as to prevent accurate observations.

At 300 miles out, the first observation of the sun was obtained, and by tables prepared in advance, the flyers were able quickly to determine their position. Early in the day, the *Chateau-Thierry* was sighted, at about half-past two another ship, the *Soloma*, and later in the day the *President Cleveland*. Radio communication was established with these ships, and from them the position of the plane was determined. Darkness was coming on, accompanied by thicker and deeper clouds; so they climbed above the clouds to 10,000 feet for celestial observations. Here the temperature was extremely low and frost was affecting the carburetor of the center engine, which slowed down and caused the plane to settle slowly to 3000 feet.

In the warmer temperature, the frost thawed out, the center engine picked up, and they climbed back to 7000 feet where they obtained further celestial observations. Finding that they were ahead of their schedule, and wishing to land by daylight they throttled their engines down to half speed, and made for the island of Kouai, which was sighted at 6 A.M. They now circled Kouai and finally, driving ahead at full speed, crossed Kouai channel and made an easy landing on Wheeler Field, dropping down at the north end of the field.



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Radio Notes

A Monthly Review of Progress in Wireless Communication

CONDUCTED BY ORRIN E. DUNLAP, Jr.

C. R. Hanna, one of the inventors of the loudspeaker known as the "exponential horn," developed in the Westinghouse laboratories. When tested in Pittsburgh, the sounds from the reproducer were clearly heard three miles away. The reproducer unit is shown here in the foreground

An "Exponential Horn"

A NEW invention called the "exponential horn," which is said to hurl the natural voice or tones of music across a distance of a mile without distortion, has been demonstrated by the Westinghouse Electric and Manufacturing Company.

The music of famous bands, orchestras, singers and choirs was reproduced through the new horn by means of a phonograph from the Westinghouse Building. Listeners three quarters of a mile away heard floating over the valley the lowest tones of the organ and bass horns and the shrillest tones of the piccolo, in perfect harmony and clearness. They heard a recitation of Kipling's "Boots" and "Gunga Din" by phonograph distinctly and naturally.

The new horn is the invention of Clinton R. Hanna and Dr. Joseph Slepian of Pittsburgh. They have obtained a patent on the horn and expect to have it put on a commercial basis.

The secret of the volume lies in a mathematically precise enlargement of the tone chamber so as to allow the tone sounds to "get a grip on the air." The volume and clarity are due to the construction of a tone chamber four feet deep and one foot wide. The inner nature is the secret of Dr. Slepian and Mr. Hanna. However, other engineers said the tonal chamber possibly was constructed with shafts, so that there was little need of amplification or "push" to put the sound waves on the air. When amplification or electrical energy is employed, there always is distortion, according to engineers.

The exponential horn is four feet square, yet it operates on less electrical energy than is required to operate the ordinary radio loudspeaker.

Colvin K. Lee, general engineer of the Westinghouse Company, explained the principle of the exponential horn by comparing its operation to cupping the hands at the mouth and calling out loudly, as in a quarry or a glen. The sound is not qualified but is given impetus on natural sound waves so that it is carried for a great distance.

New Tube Works on Alternating Current

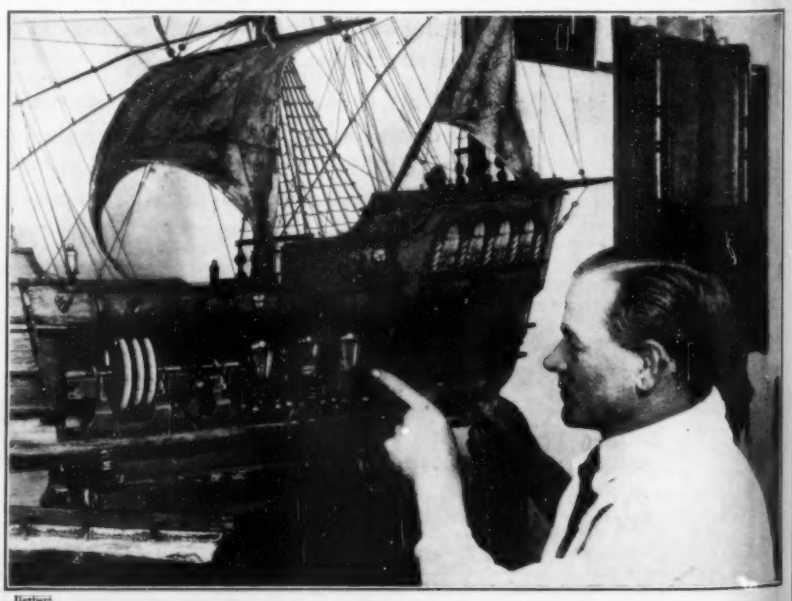
A RADIO vacuum tube designed to take its filament and plate power from either direct or alternating current of 110-volt mains without changes in the wiring of the set has been introduced in New York by Dr. Frederick W. Zons, the inventor. It was pointed out that heretofore almost without exception radio tubes have been constructed to operate from a source of reduced voltage, such as the output of a small transformer.

The size of the Zons tube is such that it can be utilized without change, wherever general-purpose receiving tubes of the six-volt type are used. It fits the standard sockets. The house current, either alternating or direct, is led by specially designed connectors directly to two terminals at the top of the bakelite base of the tube, which are connected to the two interior heating elements. These heaters are not connected metallically to the receiver circuit.

Heat generated in the two heater elements is given off to a thimble of nickel which is coated with oxides that emit large quantities of electrons when the proper operating temperature is reached. This thimble corresponds to the filament in the ordinary receiving tube. A connection is made from the thimble to the two "A" battery terminals of the standard base, forming the grid-return connection to the receiver. It is this method of connection that makes the new tube applicable to any receiver without any changes in wiring, according to the inventor. The other elements within the tube are the customary grid and plate.

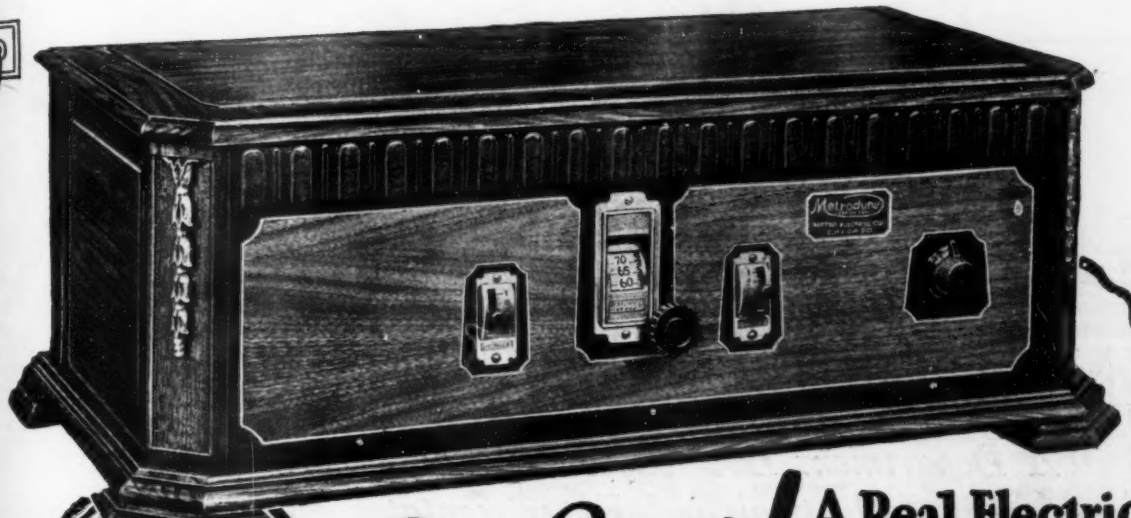
The heating elements consist of small tungsten wire coils, wound on refractory tubes. According to Dr. Zons the heaters are designed to safely withstand voltages 100 percent in excess of voltages supplied by ordinary lighting circuits.

(*Continued on page* 271)



Herbert

The model of the *Santa Maria*, built by Karl Bauer of New York, serves as the cabinet for a radio set. Violin wood was used in the construction. The sails serve to reflect the sounds from a small loudspeaker within



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The Metrodyne All Electric Radio is a 7 tube, single dial set. Only the highest quality low loss parts are used throughout. Solid walnut cabinet, beautiful two-tone effect, with handsome gilt metal trimmings. Size of cabinet, 28 inches long, 13 inches deep, 10 inches high. Has electrically lighted dial so that you can log stations in the dark. Only one dial to tune in all stations. Excellent tone qualities — wonderful volume — very selective.

Gorgeous Console Electric Radio

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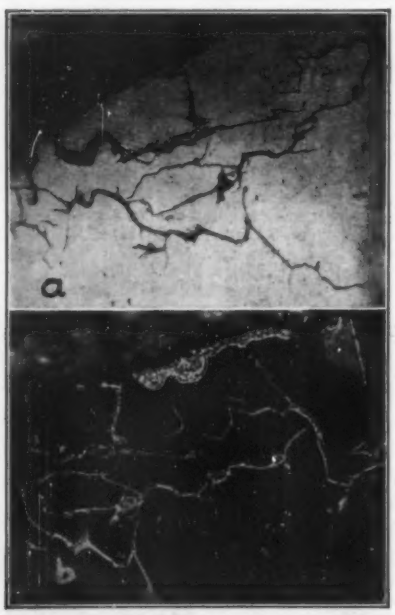
A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

CONDUCTED BY D. H. KILLEFFER

Intercrystalline Corrosion of Metals

FREQUENTLY the failure of metals is caused by corrosion of the layers between the minute metallic crystals forming the mass, according to Henry S. Rawdon of the National Bureau of Standards. In discussing, before a recent meeting of the American Chemical Society, the problem thus presented, Mr. Rawdon concludes:

"In general, any practical remedy for the trouble must be along one of two lines. The stress acting on the metal, whether internal or externally applied, may be reduced considerably below the yield point of the metal. Most of the short-time laboratory tests have shown that in order to produce failure within a reasonable time in the laboratory, the metal must be stressed close to its yield point. The practical solution of the problem of corrosion cracking in wrought brasses and other copper alloys has been along this line. The other method is to reduce the corrosive attack either by protective coatings, as in the case of duralumin, or by preventing so far as possible the formation and accumulation of the corrosive solution, as in the treatment for the prevention of "caustic embrittlement" of boiler plate. There appears also to be a possible third solution applicable in certain cases, which depends upon a change in the structural conditions in the alloy, particularly as related to the grain boundaries, by suitable heat treatment or possibly other processes."



Photomicrographs of mild-steel boiler plate, magnified 250 times, showing cracks, or "caustic embrittlement"

Tear Gas as a Fumigant

THE weapons of chemical warfare are being more and more widely applied to peace time problems, and the latest investigation of this subject has been conducted by Hoyt and Ellenberger of the Larkin Company, Buffalo, New York. These investigators have studied the effects of chloropicrin, a well known tear gas, when used for fumigating foodstuffs. The conclusions of their researches, as reported in *Industrial and Engineering Chemistry*, follow:

"Food products exposed to commercial fumigations with chloropicrin were apparently undamaged in any way. The foods tested included (1) flour, cocoa, macaroni, rolled oats in paper bags, and lard and butter in one-pound cartons exposed one week to a concentration of 0.8 pound per 1000 cubic feet; and (2) raisins, prunes, nuts in shell, nut meats, lard, and nut margarin exposed in open containers for one week to a concentration of 1.33 pounds per 1000 cubic feet.

"Germination tests on buckwheat, corn, oats, sunflower, and wheat showed that exposure for one week to a concentration of 0.8 pound of chloropicrin per 1000 cubic feet had no detrimental effect on the germinating power of these seeds, the germinating power of wheat and buckwheat being even somewhat improved thereby.

"It should be emphasized that the limited experience gained from these few fumigations does not warrant any *final* conclusions concerning dosages, method of application or effectiveness of chloropicrin against various species of insects. Much additional data on fumigation tests under a variety of practical conditions must be accumulated before chloropicrin can be correctly and properly evaluated as a fumigant. We believe, however, that chloropicrin has great merit as a fumigant, by reason of (1) the protective warning produced by its lachrymatory power in high dilutions, (2) the fact that it appears

(*Continued on page* 275)

Lead, magnified about six times; *a* is pure and *b* is coarse grained metal. Note intercrystalline corrosion

On the job for the Wabash every day

IN the past year the Wabash Railway has further improved its freight service by the installation of International Chain-Drive Trucks and a battery of All-Steel Semi-trailers.

This truck and trailer equipment is operated for the Wabash by the Arthur Dixon Transfer Company, one of the oldest in the country. These trucks and trailers are on the job ten hours every day and they are saving as high as 72 hours per shipment and replacing hundreds of trap cars and line cars every month.

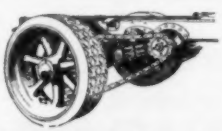
The Wabash is using International Trucks at many points in many capacities and so are all the larger railroads of the country. And that is easy to understand; International Trucks have been giving good service for twenty-three years just as other products of the Harvester Company have been giving good service for almost a century.

INTERNATIONAL HARVESTER COMPANY
OF AMERICA
606 SO. MICHIGAN AVE. (INCORPORATED) CHICAGO, ILL.

INTERNATIONAL TRUCKS

The International line includes the Special Delivery for loads up to ¾-ton; 4 and 6-cylinder Speed Trucks of 1½, 1½ and 2-ton sizes; Heavy-Duty Trucks ranging from 2½ to 5-ton sizes; Motor Coaches; and McCormick-Deering Industrial Tractors. Below are given a few points of superior International service and design. Write for folder on Internationals for your business.

International Trucks are served by 136 Company-owned branches in the United States, branches and dealers throughout Canada, and service facilities in foreign countries the world over. The branch illustrated is in Boston, Mass.



The forged steel radius arm includes a convenient chain adjustment. In the heavier models the live axle has a 2-speed range, assuring efficient power transmission in all going.

Herringbone Gears in double reduction drive models assure greater torque capacity and better all-around performance.

All International Trucks are provided with auxiliary rear springs. These springs come into action when needed and assure correct spring flexibility under varying loads. The type illustrated is provided for the double reduction drive Heavy-Duties. Another valuable International feature!

The Steer-Easy steering-gear makes the truck drive as easily as a passenger car, relieving the cramped, tiring position of driver.

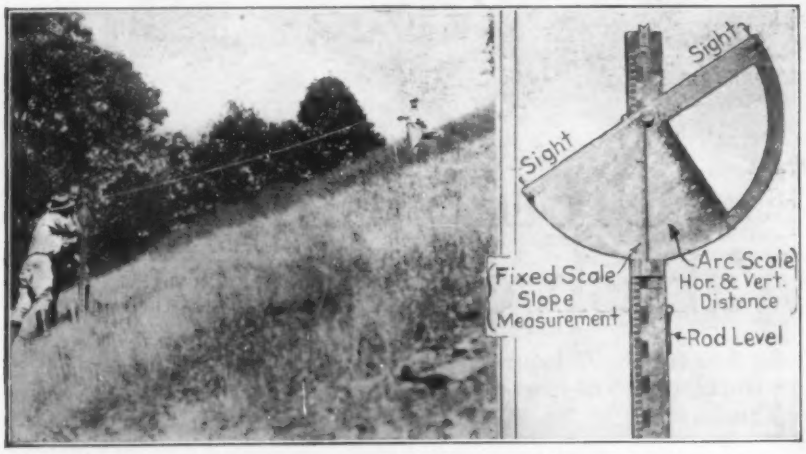
Applied Science for the Amateur

A Department Devoted To the Presentation of Useful Ideas Material of Value To All Will Be Found Here

CONDUCTED BY A. P. PECK

Practical, Home Made Surveyor's Instrument

MR. W. T. RHODES, resident engineer of the California Highway Commission on the Yosemite road, has invented a device for cross-sectioning and slope staking, which saves the surveyor's time and labor. It consists of a simple arrangement of scales on a staff or rod, combined in such a manner that distances to a point vertically and horizontally are readily obtained graphically when the slope distance is known by measurement.



This simple surveyor's instrument is light and portable, and can be set up almost instantly. It is very much easier to handle than a transit

On this instrument horizontal and vertical distances, representing respectively the base and altitude of a right-angled triangle, are read from scales on a movable arc turning about a horizontal axis pin at a definite height. The slope distance, which is the hypothenuse of the triangle in the case, is then read on the fixed vertical scale. Turning the arc and sighting at the point whose elevation is desired, determines the vertical angle: this is the principle on which the implement works.

The operation of taking cross-sections consists of setting the instrument on a station or point whose elevation is known. The instrument is first plumbed by means of a rod level attached to the staff. It is then held steady in this position by a man who also holds the tape. The observer sights on the point or rod held by the rodman, who holds the zero end of the tape. The arc is clamped in position and the slope measurement is taken with the tape. Applying the slope measurement to the fixed scale, the observer then reads the vertical and horizontal distances directly from the respective scales on the arc.

The device can be used equally well for original or final cross-sections, setting slope stakes, reference points from center line, or re-establishing the center line from reference points. A three-man party can handle efficiently the work in mountainous and rugged country. The instrument replaces the transit in the method of taking cross sections by slope angles and slope measurements.

Testing Storage-Battery Electrolyte

AT best, storage batteries of the lead plate-acid type are comparatively delicate pieces of equipment, despite their size and great weight. Often it takes only a slight irregularity of the composition of the electrolyte to cause the battery to give unsatisfactory service. In a recent issue of *Power*, Mr. Anthony N. Christopher tells how the electrolyte may be tested by very simple means. Mr. Christopher writes in part as follows:

"Storage-battery equipment of power plants is usually quite expensive and has a comparatively short life. While a slight abuse in charging or discharging is sometimes unavoidable, the worst enemy of a battery is an impure electrolyte. For this reason only pure distilled water and battery sulfuric acid should be used. Water from a faucet may contain traces of minerals. Iron, platinum, copper, nitrates and chlorine in the solution are harmful to the battery in a greater degree than any other impurities, and doubtful water, acid or electrolyte should be tested to determine if it contains any trace of these substances.

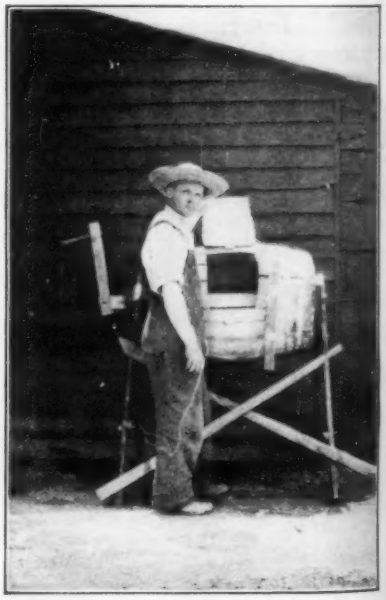
"Iron is one of the chief enemies of the storage battery. To make a test for this metal, neutralize a small amount of the electrolyte with ammonia. Then add an equal amount of hydrogen peroxide and boil. After thus heated, mix with ammonia or caustic potash until the liquid becomes alkaline. The forming of a brownish red precipitate shows the presence of iron in the electrolyte.

"The slightest trace of platinum in the storage-battery solution causes local action, and it is evidenced by gassing of the battery when on open circuit.

"Mercury in itself does no harm in a battery, but it often combines with other metals to cause local action, and if in sufficient quantity, it may amalgamate the plates. To a sample of the electrolyte add lime water. The formation of a black precipitate indicates mercury. Another test for this metal is to add a solution of potassium iodine to the electrolyte. If it contains mercury, an olive-green precipitate will be seen. To a sample of electrolyte add amomnia slowly, and if there is copper in the solution a bluish white precipitate will be obtained."

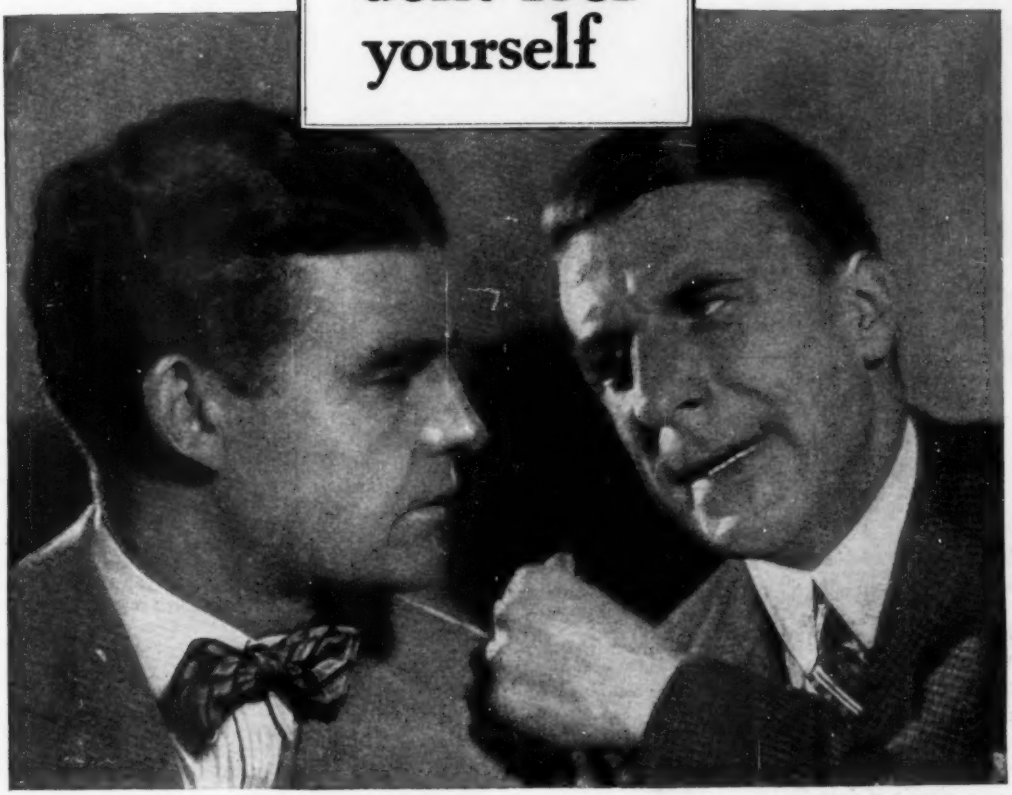
Controlling Wheat Smut

CONTROLLING wheat smut by the use of a home-made device such as the one illustrated is an easy matter. Copper carbonate dust is placed in the barrel and the light, fluffy powder is mixed with the seed wheat so that a light film is applied to every kernel. Inside the barrel is a board fastened at right angles so that it can bring about a better mixing of the seed and the dust. The handle is used for turning the barrel until the wheat and the copper carbonate dust have been thoroughly mixed. *Contributed by Allen P. Child.*



Seed wheat can be quickly treated for smut prevention in this barrel

don't fool yourself



Decency demands it

Don't fool yourself by thinking that you never have halitosis (unpleasant breath). The worst offenders are usually unaware of it. You, yourself, can never tell.

Therefore, common decency demands that before meeting people, you put yourself on the polite side by the use of Listerine. You simply rinse the mouth.

1/3 Had Halitosis

115 barbers say that about every third man that walks into the shop has halitosis. Who should know better than barbers?

Face to face evidence

Immediately and effectively, Listerine combats unpleasant odors arising from teeth and gums, the most common source of halitosis. And the antiseptic essential oils combat the action of bacteria in the mouth.

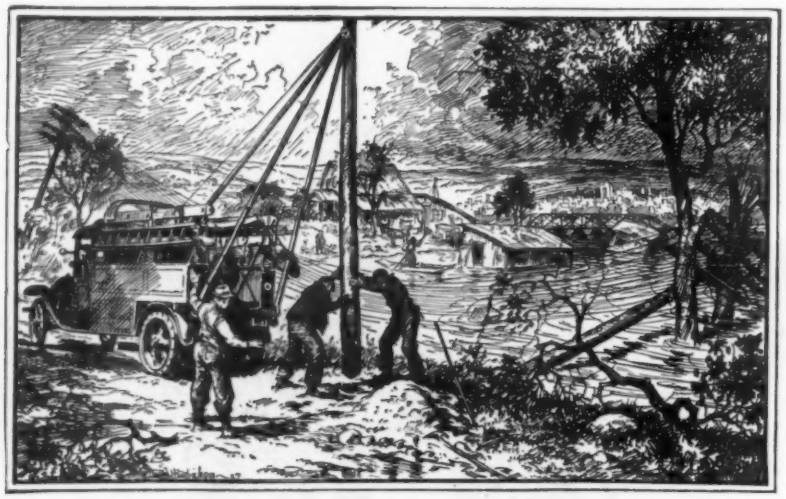
Better keep a bottle handy in home and office so that you may never offend.

Lambert Pharmacal Co., St. Louis, U.S.A.

LISTERINE

FALL IN LINE!

Millions are switching to Listerine Tooth Paste because it cleans teeth whiter and in quicker time than ever before. We'll wager you'll like it. Large tube 25c.



All for One

An Advertisement of
the American Telephone and Telegraph Company

A SLEET storm descends, carrying down trees and wires. A wind turns outlaw and blows down a pole line. Or some swollen river rampages through a circuit of destruction.

But wherever angry nature attacks the Bell Telephone System there are repairmen trained to meet the emergency, and everywhere trained in the same schools to the use of the same efficient tools. Supplies of surplus equipment and materials are kept at strategic points whence they may be rushed by train or truck to the devastated area.

Throughout the Bell System, all construction and practice are standard, so that men and supplies, when necessary, may be sent from one state or company to another.

There are twenty-five Bell Companies, but only one Bell System—and but one Bell aim and ideal; stated by President Walter S. Gifford as:

"A telephone service for this nation, so far as humanly possible free from imperfections, errors and delays, and enabling anyone anywhere at any time to pick up a telephone and talk to anyone else anywhere else in this country, clearly, quickly and at a reasonable cost."

BECOME A FOOT CORRECTIONIST

$3,000 to $10,000 yearly in a business of your own—many are making it in the New Profession of foot correction, not medical nor chiropody. Openings everywhere with all the trade you can attend to; easy terms for license and training by mail; no further capital needed, or goods to buy; no agency or soliciting. Write today for full details.

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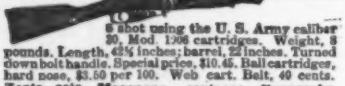
RUSSIAN SPRINGFIELD SPORTING RIFLE
$10.45



5 shot using the U. S. Army caliber 30, Mod. 1906 cartridges. Weight, 8 pounds. Length, 42¾ inches; barrel, 22 inches. Turned down bolt handle. Special price, $10.45. Ball cartridges, hard nose, $3.50 per 100. Web cart. Belt, 40 cents. **Tents, cots, Messpans, canteens, Knapsacks, haversacks, Outing Suits,** hats, helmets, **Saddles, bridles, Bugles,** lariats, **Medals,** etc. **18 Acres Army Goods. New Catalog 1927** Collection issue. 240 pages, fully illustrated, contains pictures and historical information of all American Military guns and pistols (incl Colts) since 1775, with all World War rifles. Mailed 50c. Est. 1865. **Spec. New Circular** for 2c stamp. **Francis Bannerman Sons, 501 Broadway New York City**

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Formerly instrument maker for the Rockefeller Institute for Medical Research

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SCIENTIFIC AMERICAN

The Scientific American Digest

(*Continued from page* 255)

mercury boiler (Hartford Electric Light Company, Hartford, Connecticut,) to give a permanent record of the mercury-vapor content in the flue gases. It has given very satisfactory service and proved to be a valuable instrument for the control of the condition of the boiler, having made it possible to show that during a long period of tests the leakage of mercury from the boiler is negligible. The sensitivity is such that the introduction of a few drops of mercury into the furnace will immediately be registered distinctly by the recorder.

"In a similar way the concentration of mercury-vapor in the boiler room has been watched, and as expected, it was found to be so low that any danger of poisoning is practically out of the question. In this connection it might be of interest to mention that it was found that if water is poured on top of mercury, the rate of evaporation of the mercury out in the atmosphere is considerably depressed. Wherever mercury is left in open dishes it should, therefore, be covered with water.

"Sometimes in repair jobs, it is necessary to work in places over mercury. Experiments have shown that in such cases commercial gas masks with a canister filling containing activated charcoal, like the Burrell gas mask, are very effective in removing all mercury from the air and therefore in eliminating all danger of inhaling mercury. Since a means of detection of a danger is always a pre-requisite of its control, it thus seems justifiable to hope that the health hazard, as already in the case of the mercury boiler, so eventually in other industries where mercury is used, is in a fair way to be diminished if not quite done away with."

The New Inside-Frosted Electric-Light Bulbs

NOW that electric-light bulbs, frosted on the inside, have become common, many readers are inquiring whether there is not a considerable loss of light, due to the frosted surface. The loss is about 2 percent greater than that in the plain bulb of clear glass. The loss in the case of the old, outside-frosted bulb was from 6 to 8 percent.

Why the old, plain, non-frosted bulbs have been supplanted has been explained by the American Institute of Electrical Engineers in the following manner:

"For many years lamp engineers realized that a lamp frosted on the inside, instead of on the outside, would be very desirable. It would not only present a smooth outside surface and be as easily cleaned as a clear lamp, but a lighter frosting would suffice, increasing the efficiency. The trouble with the idea was, that when a lamp bulb was frosted on the inside, it became as brittle as an egg shell. For 20 years engineers wrestled with this problem to no avail, until Marvin Pipkin, of the General Electric Company at Nela Park, solved the difficulty. The method is simple.

"A strong solution of acid is first sprayed into the bulb, which etches it. In this condition the surface of the glass is made up of irregular little projections with many sharp angles. While the glass is still in this state it is extremely weak, and a slight pressure or

Old Briar

TOBACCO

"THE BEST PIPE SMOKE EVER MADE!"

"It came, and is the best tobacco I ever smoked!" Justice———*

Such convincing praise for Old Briar Tobacco from such a pipe smoker means far more to you than anything we can say. Old Briar is bringing back to pipe smokers all of the old peace, contentment, satisfaction and solid comfort of pipe smoking. Vast multitudes—men whose opinions may be divided on a thousand subjects—are united on this wonderful smoking tobacco.

Light up *your* pipe—filled with Old Briar Tobacco. Draw in its ripe fragrance, its full, pleasant aroma. Smoke it awhile. Enjoy its natural tobacco taste, its rich body. Notice how cool it is—and how extra smooth.

Years of scientific knowledge in the art of mellowing and blending and generations of tobacco culture have gone into the production of Old Briar Tobacco. Step by step Old Briar has been developed—step by step perfected.

Of all the pleasures man enjoys, pipe smoking costs about the least.

TO DEALERS: Old Briar is sold in sealed Pocket Packages at 25c and sealed boxes at 50c, $1.00 and $2.00. If your jobber has not supplied you, write us and we will send you a supply by prepaid Parcel Post at regular Dealer's prices. Every box and package of Old Briar has our unlimited guarantee.

UNITED STATES TOBACCO COMPANY, RICHMOND, VIRGINIA, U. S. A.

*The above unsolicited praise is from a judge who used this coupon ☞

IF YOUR DEALER DOES NOT HAVE OLD BRIAR

Mail this coupon to United States Tobacco Co., Richmond, Va., U. S. A.

SPECIAL OFFER: So many thousands have found so much extra enjoyment in a pipeful of Old Briar, it is a guarantee to you that you, too, will find it is the best tobacco you ever smoked. On receipt of this coupon with your name and address, we will mail you the regular 50c size of Old Briar Tobacco. In addition we will send you a 25c package of Old Briar—extra—if you send us your dealer's name. Send no money, but pay the postman only 50c when he delivers the tobacco.

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Tear out coupon now, while it's handy. S. A. 9-27

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Non-Skid Hi-Type Tires are recommended for any trucking service that demands a balanced combination of the three essential truck tire qualities—Cushion, Traction and Mileage. They are built in a complete range of sizes from 4" to 14" providing single or dual equipment, as conditions warrant, for trucks and trailers of practically any size. The non-skid tread is especially designed with large units to give the tire more traction surface. The deep grooves increase the cushioning qualities and keep the action near the surface where the heat is quickly dispelled. Your Firestone Dealer has a full line of specialized truck tires with which he will save you money and serve you better. See him today.

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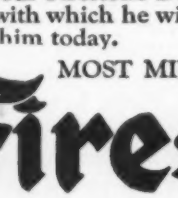

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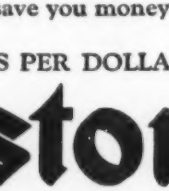

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bump is sufficient to shatter it. So far, the process is similar to former attempts at inside frosting. The difference lies in the strengthening process, which is the application of another acid solution, somewhat weaker than the first. This second treating rounds off the sharp edges and minute projections, giving the glass an appearance, under a powerful microscope, of being made up of tiny hemispheres. The bulb is now strong again—just as strong as it was originally.

"Diffusion of the light by the inside frost is obtained by prismatic refraction with comparatively little loss. In fact, the inside frost allows an even greater portion of the light to pass through than does a similar frost on the outside of the lamp. This is due to the fact that the multiple internal reflections are not so numerous in the inside-frosted lamp because the rough, interior surface does not reflect any considerable portion of the light back and forth inside the lamp, as happens with the outside-frosted lamp. Moreover, the relative absorption of the inside frost does not increase so rapidly with the life of the lamp as does that of other diffusing media."

Windmill Power

"THE cost, therefore, of windmill-generated electricity, either for small lighting or for small power purposes, is quite reasonable and such as to justify a wider use." This quotation is from

The ventimotor, one of the several new types of wind-electric power generators made in England

"A Report on the Use of Windmills for the Generation of Electricity, Bulletin Number 1," rendered by the Institute of Agricultural Engineering of the University of Oxford, England, and published by the Oxford University Press, American Branch, New York.

The Institute of Agricultural Engineering at Oxford has been making some unusually exhaustive tests on a number of commercial types of windmill power-generating outfits suitable for farms and similar purposes. No American makes

were tested, as far as the report indicates, but those of our readers who, judging from our mail, take keen interest in the question of windmill power, will doubtless find much information of interest in it, despite the recognized fact that many conditions, both economic and technical, are not the same in America as in England. The report forms a 63-page pamphlet with several excellent plates.

Scientists Find Parent Substance of Vitamin D

THE anti-rachitic vitamin over which dieticians, health authorities and the possessors of young offspring have been so deeply concerned for the last few years, is nearly tracked down to its original source. The younger generation will be interested to know that a preparation many times more potent than cod-liver oil to prevent and cure rickets is ready to be tried out by physicians.

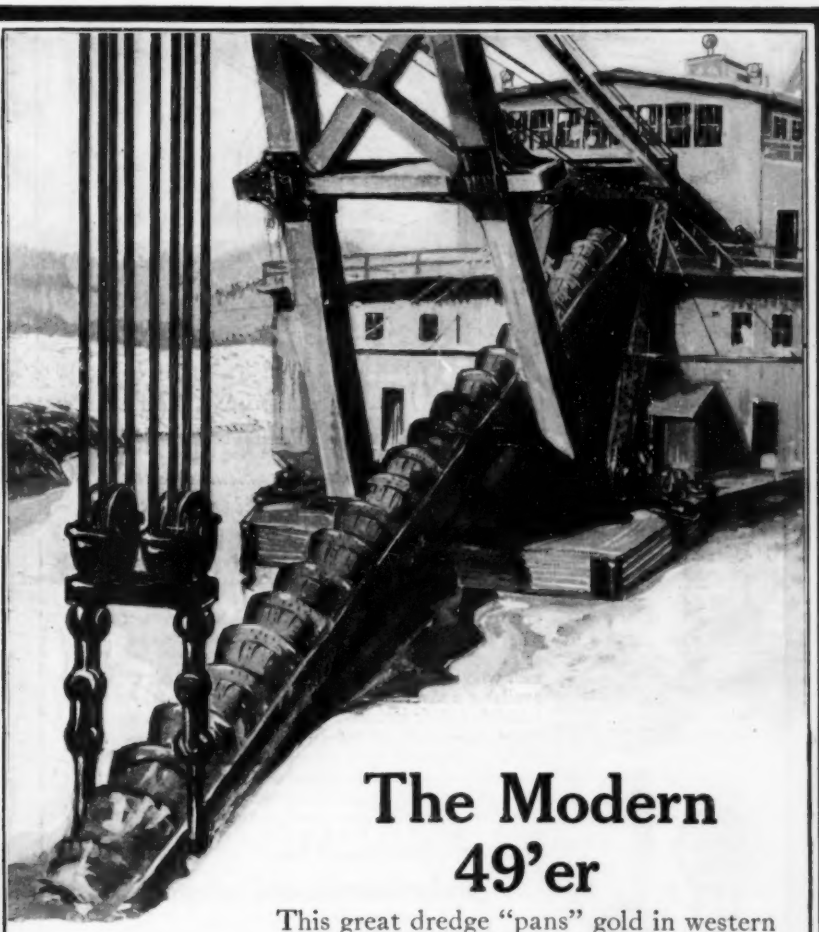
Scientists here and in Europe, working in more or less collaboration on the problem, have come to the same conclusion, says Dr. Alfred F. Hess of the College of Physicians and Surgeons at Columbia University, that the anti-rachitic vitamin D is formed when certain sterols, a group of substances similar to fats, widely distributed in the lower plants, are exposed to ultra-violet light. Both Dr. Hess and Drs. O. Rosenheim and T. A. Webster of the National Institute for Medical Research in London have collaborated with Prof. A. Windaus of Gottingen University in Germany, who has been engaged in research on the chemical problems involved in the isolation of the anti-rachitic vitamin for several years.

About two years ago Dr. Hess reported that cholesterol, occurring in all animal fats and oils, and its counterpart, phytosterol in vegetable foods, after irradiation with ultra-violet light, was the substance actually responsible for preventing rickets. Irradiated cholesterol in very much smaller doses would produce the same results as cod-liver oil, only one millionth of a gram being necessary to protect a rat from rickets.

Now, however, another step in the pursuit of the vitamin has been accomplished. The English workers, as well as Dr. Hess and Prof. Windaus, all believe that it is only a small portion of the cholesterol which is activated by ultra-violet light. This is an allied substance called ergosterol. This compound is widely distributed in lower plant forms and only very minute quantities are needed to protect laboratory animals from rickets.

"It was found," says Dr. Hess, "to bring about a healing process of the bones when even as little as three ten-thousandths of a milligram per capita daily was given. In tests in which irradiated cholesterol is fed, it has been found that approximately one milligram is needed to initiate healing. Other experiments will be undertaken to ascertain the relationship of ergosterol to cholesterol and the extent of its distribution in the animal body."

The practical value of the discovery of this concentrated form lies in the fact that it will be possible now to dispense with the malodorous and nauseating cod-



The Modern 49'er

This great dredge "pans" gold in western waters, very much as did the miner of more romantic days.

Soil from the river bottom is scooped up by the chain of traveling buckets and carried inside, where it is robbed of its gold and literally thrown outside.

Wire rope plays the important part of sustaining and handling the "bucket ladder." The work is severe; the prime reason why Yellow Strand is so generally used.

For economical hard work, Yellow Strand is supreme. The single strand of yellow is your protection.

This pioneer wire rope company also makes all standard grades for all purposes.

Motorists

Carry a Basline Autowline in your car and safeguard your spare tire with Powersteel Autowlock. Both are made of Yellow Strand. Ask your accessory dealer.

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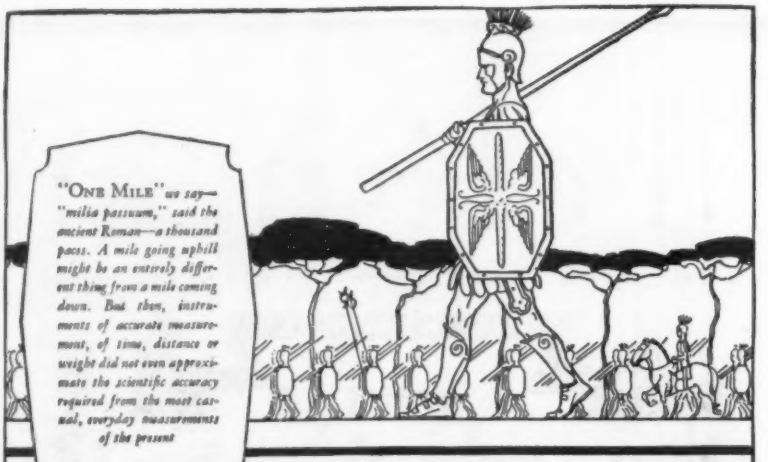
Yellow Strand WIRE ROPE

LB648



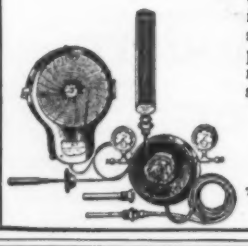
"ONE MILE" we say—"milia passuum," said the ancient Roman—a thousand paces. A mile going uphill might be an entirely different thing from a mile coming down. But then, instruments of accurate measurement, of time, distance or weight did not even approximate the scientific accuracy required from the most casual, everyday measurements of the present

The essential of an instrument of measurement you sell is that it tell the TRUTH

No merchant would intentionally sell eleven eggs and tell the buyer it was a full dozen. In selling scientific instruments of measurement the obligation is just as accurate—for human life and business life today often depend on the accuracy of the instruments with which we protect it.

The developers of the thermometer were painstaking scientists satisfied with nothing but accurate truth. The men who make the discoveries of those ancient pioneers available and useful today are just as painstaking and faithful in their insistence on nothing but utter accuracy.

There is scarcely an industry where some of the eight thousand styles of *Tycos* Instruments are not used. There is scarcely a human activity but where *Tycos* is making life safer, healthier and more profitable. Such a condition implies vast responsibilities—how these responsibilities are met is indicated by the fact that men of medicine, of science, of industry demand *Tycos*.



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liver oil. Hitherto it has been the practice to resort to such general remedies as sunlight and a diet of foods known to contain anti-rachitic elements. A German authority has suggested that one of the consequences of this research will be to put oleomargarine products on an equal basis with butter and cream, for the irradiated oleo will now have the same anti-rachitic constituents as real butter.—*Science Service.*

Vanadium New Member of World's Metal Family

THE addition of a new metal, vanadium, to the world's resources, is announced by J. W. Marden and M. N. Rich, research scientists of the Westinghouse Lamp Company.

Vanadium has been known in its compounds for a long time, according to Drs. Marden and Rich, but in spite of a century of efforts on the part of chemists, no one has previously been able to produce it in its pure form. The method employed by the authors is to heat a mixture of vanadic oxide, metallic calcium and calcium chloride in an electric furnace for an hour at a temperature of nearly 1400 degrees, Fahrenheit. After cooling and stirring the resulting mass in cold water, metallic vanadium is obtained in the form of beads.

"The beads of vanadium are very bright, have a steel-white color and are quite malleable, soft and ductile," say the authors. "They can be melted in a vacuum in a high-frequency induction furnace, rolled into wire and worked up into other shapes. As far as analysis can determine, they are 99.9 percent pure metal.

"There is no known use for this new metal at present, but undoubtedly it will have special properties that will make it useful. Tungsten, for example, was once a useless metal, but is now of inestimable value for filaments in incandescent lamps, for high-speed tool-steel alloys and many other purposes. Vanadium may, in time, prove equally serviceable."—*Science Service.*

Wild Duck Wears Legband Over Twelve Years

THE growing practice of bird banding is revealing surprising instances of the longevity of birds. The United States Biological Survey has recently received a "return record" of a pintail duck treated for duck sickness in Utah by Dr. Alexander Wetmore of the Smithsonian Institution back in September, 1914. The duck was cured and released by Dr. Wetmore after having affixed to it Biological Survey band No. 519. In October, 1926, the bird was shot by H. W. Seybert in California, showing that the band had been carried for over 12 years. Since the duck was a full-grown bird fully a year old when it was released it must have been at least 13 years old when shot.

Scientists commenting on the incident in the ornithological journal, *Condor*, consider it "a most remarkable record in view of the fact that each season it had run the gauntlet of hunters and also had escaped the poisonous alkali areas where many thousands of ducks die annually from duck sickness, and other natural enemies."—*Science Service.*

Radio Notes

(*Continued from page 260*)

When operating from lighting circuits supplying 110 volts direct current, both "A" and "B" batteries may be eliminated. The 110-volt current is applied directly to the filament of the tube and the same voltage, with a simple filtering device, is utilized to supply the plate voltages required. The tube operates at maximum efficiency at approximately 90 volts plate potential. This makes it impossible to burn out the filament of the tube by short-circuiting the "A" and "B" circuits, as the two voltages are practically equal.

Dr. Zons' laboratory tests are said to indicate that the vacuum and operating characteristics of the tube become more desirable as the tube life increases, principally because the operating temperature of the active oxide on the coated cylinder does not become excessive. This condition is conducive to long tube-life. A receiving demonstration was heard, utilizing a tube that was said to have successfully withstood 220 volts on its filament for several minutes. Tests have also shown that no decrease in signal strength occurs until filament voltages of less than 75 percent of the rated 110 volts are utilized. Fluctuating line voltages, therefore, show practically no undesirable effects.

How Marconi Beam Dodges Sunlight

INVISIBLE shafts of electric power, sweeping across the surface of the earth, with London as the central point of radiation, now encircle the globe in the twinkle of an eye. Picture a great lighthouse in London with a beam sufficiently powerful to sweep around the earth, and that, in effect, is what the Marconi beam system amounts to in its operation between England, Australia and India.

Three masts 260 feet high hold aloft the aerial wires from which the beam is directed to Australia. Five masts 287 feet in height are used for the service to India. The radio reflector, which concentrates the waves in the desired direction as the reflector of a searchlight directs rays of light, consists of 64 vertical wires. The reflector is located behind the aerial at a distance one quarter of the wavelength used. The beam is projected from the aerial system at right angles to the plane of the masts.

It is pointed out by the engineers that, once the message is given the right direction, physical geography plays a leading part in the transmission. They say that when traffic is sent east to Australia, the route of the beam is across north-central Europe, southwestern Asia and India, following the great circle toward the Antipodes—the exact position of which is near the islands of that name southeast of New Zealand.

After shooting out from Grimsby, England, the beam widens until it reaches its maximum width of 16 degrees and then contracts until it strikes Australia. The beam naturally follows the shortest—in this case the eastern—route, which is about 10,500 miles. But transmission is not always easiest by the shortest way, and at sunrise in England the alternative western route—across the Atlantic and Pacific—is used, the distance on the great circle in this case being 13,500 miles.

The operators at the receiving station at Skegness listen for the change and when

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fading begins, send a message to the transmitting station at Ballan, near Ballarat, Victoria, to switch over. The change is effected in a fraction of a second. It simply means—as at the Tetley station—the turn of a switch in the transmitting shed. The aerials have been arranged so that one set can be energized for the eastern and one for the western route while the reflector in the middle serves both and concentrates the energy in the desired direction. Two directions and one wavelength are used in the Australian service and two wavelengths and one direction will be used for India.

Despite interruptions from the change of direction, the Australian service operated both ways on the day it was opened for public service at over 100 words per minute for 19 hours, while the contract calls for seven hours only. Signals were audible on that day for 22 hours out of the 24. The wavelength used for Australia is 25.9 meters, while the return service uses 25.7 meters.

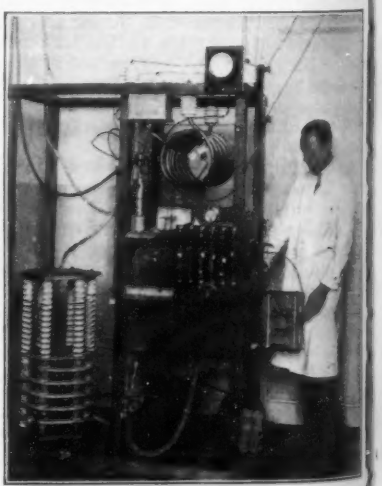
Pictures Enlarged When Received

PHOTOGRAPHS sent by radio are enlarged to nine times their original size by means of a new receiving apparatus designed by engineers of the Radio Corporation of America.

The possibilities of the new receiving device were illustrated when full-size advertisements of a fashion magazine were radioed successfully. Radio engineers are now working on a receiving device which will make pictures 18 times as large as the original.

The paper used in receiving the picture was made especially for photo-radio reception. It is said to be based on a formula discovered by paper experts. A wave of heat blown on this paper will make an impression upon it.

The actual enlarging is done by a small asbestos device attached to a rubber tube, through which hot air is constantly being blown. A tiny opening at the end of the tube lets hot air blow on the paper, making a black mark. The pictures are produced, however, by a second tube carrying cold air, the passage of which to the paper is controlled by radio signals.



F. M. Delano

The short-wave transmitter used by Edouard Belin in his television experiments conducted in France. It operates on the 30-meter wavelength

If the cold air passes in front of the current of hot air, it prevents the hot current from making a mark on the paper. Thus there is obtained the succession of black dots and lines and white spaces which, when seen together, make the picture.

Record Transmission Without Antennæ

THE following report is made by the navy of what is believed to have been the longest two-way communication without transmitting antennae:

"Communication was established between the Naval Research Laboratory, NKF in Washington, D. C., and Navy

The Langmuir exhaust pump used by the General Electric Company for evacuating radio tubes. Three pumps are used in the process. The last one is assisted by chemical means to remove water vapor, or a refrigerant is used to freeze it out

Research Station 4XE at Winter Park, Florida, on 13,940 kilocycles. When NKF disconnected its transmitting antenna, only a slight reduction in signal strength was noted at 4XE. A few minutes later 4XE disconnected its transmitting antenna, still continuing two-way 'break-in' contact with NKF, the radiating systems at both stations consisting only of the helices. So far as is known, this is the first two-way communication carried on over a distance of approximately 900 miles without transmitting antennae."

In Touch With Home

THE American yacht, *Kaimiloa*, sailed from San Francisco in October, 1924, for a wandering cruise in the South Pacific. Fred G. Roebuck, the radio operator, returned to New York recently and told how short waves brought him thousands of news dispatches, some direct from the Times Square district, 10,000 miles away from the ship's antenna. He said that, while in New Zealand waters, he talked direct with his father operating an amateur short-wave station in California. He said that the 40-meter waves carrying news from New York were "most astonishing—perfectly steady and remarkable—almost unbelievable."

The call letters of the *Kaimiloa* were KFUH and the wavelength 35 meters. The ship will leave on another cruise in the South Seas within a few months.

MORE POWER

Owners' Cost Sheets Show

WISCONSIN Motors have won their spurs in truck, tractor, bus and industrial installations. In each exacting service owners' costs show a definite saving per operating day.

A one-season record might easily be accidental, but the year-after-year consistency of Wisconsin's superior performance is conclusive.

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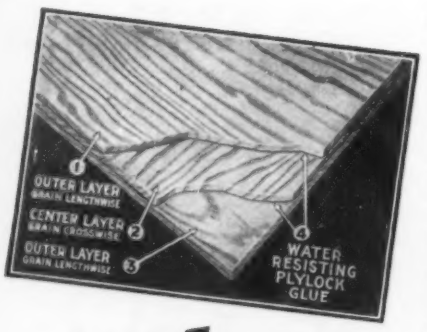

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Every manufacturer owes it to his business to investigate PLYLOCK. Already it is being used to cut costs and improve the quality of products in many lines of industry.

Write for a copy of "The Pictured Story of Plylock" and a sample. Full size samples for experimental and development work supplied on request.

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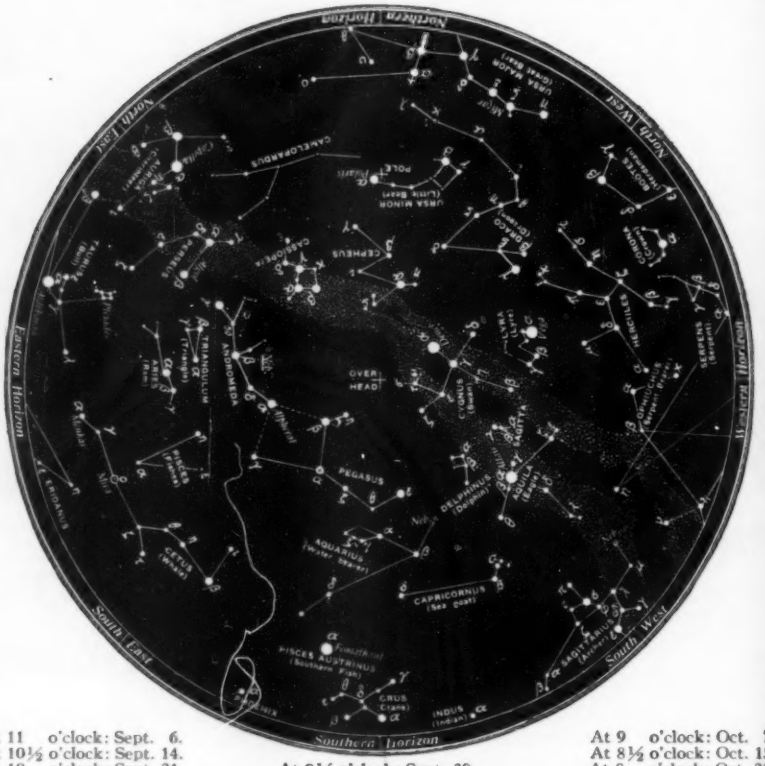
The Heavens in September

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Sept. 6.
At 10½ o'clock: Sept. 14.
At 10 o'clock: Sept. 21.
At 9½ o'clock: Sept. 30.
At 9 o'clock: Oct. 7.
At 8½ o'clock: Oct. 15.
At 8 o'clock: Oct. 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o clock on September 6, etc.

NIGHT SKY: SEPTEMBER AND OCTOBER

The Heavens

ON our map of the sky this month, we find the great constellations of summer. Cygnus, Lyra and Aquila reign in the west, with Sagittarius low in the southwest, Ophiuchus in the west, and Hercules and Corona in the northwest. The Great Bear is low in the north, the Dragon and the Little Bear higher, and Cassiopeia and Cepheus very high. Perseus, Auriga and Taurus are in the northeast, Andromeda and Aries in the east, Pegasus high in the southeast, with Cetus below, and Aquarius, Capricornus and the Southern Fish in the south.

The Planets

Mercury is in conjunction with the sun on the 2nd, and is practically invisible until the latter part of the month, when he may be seen in the twilight, but with difficulty. Venus is also in conjunction with the sun on the 11th. She may still be seen low in the evening twilight on the 1st, and comes out in the morning sky before the month's close, but in both cases clear skies and careful watching will be required to glimpse her. In the telescope she shows a narrow crescent, of great span between the horns.

Mars is an evening star, but sets less than an hour after the sun, and is very hard to see. Jupiter is in opposition on the 22nd, and dominates the midnight sky. He is in Pisces, very close to the vernal equinox, and remote from any bright star. Saturn is in Scorpio, and is now an evening star, setting between 9 and 10 P.M. Uranus is in opposition on the 25th, and is well placed for observation. He is still quite near Jupiter in the sky; indeed, at the month's beginning he is only 40 minutes east and 70 minutes north of the brighter planet. Jupiter moves westward more rapidly, and at the end of the month is 3 degrees west and 2 degrees, 40 minutes south of Uranus. Neptune is in Leo, just past conjunction with the sun, and barely, if at all, observable. This planet, however, is of little direct interest to the observer who is not equipped with at least a small telescope, for it is exceedingly faint to the naked eye. It is now not far north of the bright star Regulus. Neptune's distance from the sun is 2,800 million miles—over thirty times as far as the earth, and it requires 165 years to make a complete revolution around the sun. It has one satellite which revolves around it in the reverse direction, but this may be glimpsed only in the largest telescopes.

The moon is in her first quarter at 6 A.M. on the 4th, full at 8 A.M. on the 11th, in her last quarter at 10 P.M. on the 17th, and new at 5 P.M. on the 25th. She is nearest the earth on the 12th, and farthest away on the 27th. She is in conjunction with Saturn on the 3rd, Jupiter and Uranus on the 12th, Neptune on the 22nd, Venus on the 23rd, Mars on the 26th, and Mercury on the 27th. At 8 P.M. on September 23rd, the sun crosses the celestial equator and "autumn commences."

Industries from Atoms

(*Continued from page 262*)

not to injure food products or the germinating power of seed, and (3) that it kills or poisons beyond recovery a very high percentage of such insects as the Indian meal moth, Mediterranean flour moth and the more resistant confused flour beetle in fumigations made on a commercial scale with dosages of chloropicrin ranging from 0.8 to 1.33 pounds per 1000 cubic feet."

Influence of Rust Film on Corrosion

"DO not clean the rust off of corroded steel," is the conclusion reached by E. L. Chappell of the Massachusetts Institute of Technology, after a careful study of the influence of the thickness of rust films on the rate of corrosion of steel. After discussing his investigations before the American Chemical Society, Mr. Chappell concludes:

"A very thick film of rust is required to decrease appreciably the corrosion rate of the copper steels, and the more easily corroded steels have a much longer life when protected by even a thin film of corrosion product. This indicates the conditions under which copper-bearing steels under water would not be superior to ordinary steel—namely, where thick films are formed. On the other hand, where the rust film is removed, as by mechanical means, copper-bearing steels are likely to be more resistant. In addition, it must be concluded that the common practice of cleaning the rust accumulations from iron surfaces, such as inside water heaters and tanks, is likely to increase greatly the attack on the metal. The importance of rust-film thickness is recognized in practice, when, for example, it is pointed out that a tubular condenser will last longer if not cleaned of rust. In cases of heavy metals such as cast iron, a thick film may be allowed to build up and corrosion practically stopped.

"The effect of films of corrosion product must be carefully considered where tests of corrosion resistance are made, as neglect of this factor may lead to conditions which are not comparable to those of practice."

Re-use of Plaster of Paris Molds

THAT plaster of Paris is weakened by reburning after having once been used has long been known, and a recent investigation at the Massachusetts Institute of Technology has sought the cause of this peculiarity. The burning of gypsum to remove its water of crystallization and the hardening of the plaster thus formed by supplying water to it is well understood, but the reason why the same plaster cannot be satisfactorily regenerated by subsequent burning has not been clear. Applying X-ray methods, Dr. Marie Farnsworth has studied this problem and suggests that the addition of a small amount (¼ of 1 percent) of aluminum oxide to the plaster will improve its strength on reburning. In summarizing her results before a recent meeting of the American Chemical Society, Dr. Farnsworth said:

"It seems very likely that the deterioration of plaster of Paris on a second calcination results from the traces of uncalcined gypsum remaining. This view is

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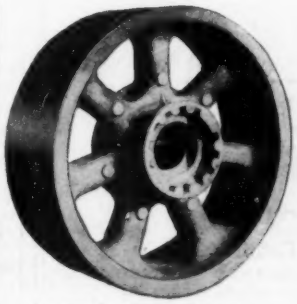
the World's Greatest Truck Makers use
DAYTON STEEL WHEELS



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Seven Spoke Rear Wheel 1927 Model

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Furthermore, brake drums are properly ventilated and never overheat. Tires, if properly applied, cannot creep on the rim.

45 Patents Owned by Dayton

Every major improvement in steel wheels has come first in Dayton Steel Wheels. Dayton was the first to patent and pioneer integral hub wheels. Not less than 45 patents are owned by the Dayton Steel Foundry Company covering both design and methods of making hollow-spoke steel wheels.

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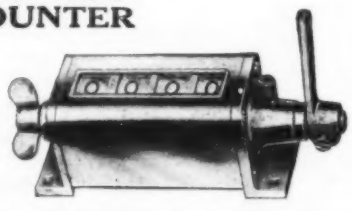
The large Set-Back Revolution Counter at right is less than ½ actual size. The Small Revolution Counter below is shown nearly full size.



The Set-Back Revolution Counter above records the output of the larger machines where the revolutions of a shaft record operations or output. Counts one for each revolution, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price, with four figures, as illustrated, $10.00 (subject to discount).

The Small Revolution Counter at left records the output of smaller machines where a shaft revolution indicates an operation. Though small, this counter is very durable; its mechanism will stand a very high rate of speed, making it especially adapted to light, fast-running machines. Will subtract if run backward. Price, $2.00.

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supported by the fact that the addition of small traces of set gypsum to good plaster causes it to deteriorate very markedly. Traces of many foreign substances cause a deterioration of plaster and it is just as likely that traces of many substances would improve it. It has been found that the addition of as small an amount as ¼ percent aluminum oxide will cause the tensile strength to increase about threefold, and no doubt other substances would be just as good, or even better, but a search was not made for such substances. X-ray photographs from new plaster and from re-used plaster show that the smaller the tensile strength, the larger is the particle size. The addition of aluminum oxide causes a decrease in the particle size and increases the tensile strength. This has a possible application in the re-use of plaster molds where the decrease in tensile strength on recalcination is not too great."

Reducing Hazard From Paint and Varnish Removers

THE poisonous nature of benzene, used in many paint removers, has long been recognized, and by altering the mixture compositions means have been sought to reduce the hazard to the health of users of these compounds. John Morris Weiss, a member of the Benzol Committee of the National Safety Council, recently reported to the American Chemical Society a research carried out to find a mixture which would reduce this hazard. He said in part:

"Paint and varnish removers have been developed which meet the practical requirements, the most widely used type being a mixture of benzene, acetone, and paraffin wax, in such proportions that there is always solid paraffin in the finished mixture. The proportions of ingredients in the various commercial removers of this type differ, but in the majority of formulas, the proportions of solvents vary from around 50 to 55 percent benzene and 50 to 45 percent acetone by volume, with the addition of from 3 to 5 percent by weight of wax. The wax is dissolved in the benzene and the acetone stirred in slowly, in this way precipitating the wax in a fine state of division. Both pure and 90 percent benzene are used in commercial removers.

"The proper use of wax in acetone-benzene removers results in an extraordinary reduction in the evaporation of the benzene. To obtain this reduction, acetone must be used in substantial amount so as to produce a solvent mixture in which the solubility of the wax is low; further, the percentage of wax should not be allowed to drop below a certain minimum, probably 5 percent by weight of the solvent used; and lastly, other conditions being equal, the retardation of evaporation is increased by an increase in the melting point of the wax used. With proper formulas, this retardation will result in volatilization figures from 1/2000 to 1/120 of the evaporation of the solvents themselve under the same conditions.

"It is, of course, impossible on purely laboratory tests to predicate an absolute absence of hazard when dealing with a substance of known toxicity such as benzene. It does appear, however, under reasonable conditions of ventilation in the practical use of properly proportioned acetone-benzene-wax paint and

varnish removers, that the concentration of vapors in the atmosphere will not become sufficient to constitute a hazard approaching that of other industries where the evaporation of the benzene is a necessary feature of the operation."

Treating Pea-Cannery Wastes

VARIOUS industrial wastes have presented serious problems to the engineer in disposing of them without nuisance. A method of disposing of the waste from a pea cannery has recently been developed by L. F. Warrick of the Bureau of Sanitary Engineering of the Wisconsin State Board of Health. Not only is the pollution of streams prevented but a sludge is obtained which may be profitably utilized for its fertilizer value. In describing the process used and researches involved before a recent meeting of the American Chemical Society, Mr. Warrick states the following conclusions from his studies:

"1—The oxygen demand of pea-cannery wastes can be reduced approximately 75 percent by screening and tank treatment with the application of seven and one quarter pounds of lime and three and one quarter pounds of ferrous sulfate per 1000 gallons.

"2—Prompt removal of the chemically precipitated organic matter is desirable, since a portion goes into solution when allowed to accumulate in the tank. The oxygen demand reduction averaged only 34 percent under such conditions.

"3—The sludge can be readily removed from the tank by means of a motor-driven diaphram pump, and it can be rapidly dried on sludge beds. Analysis indicates a fertilizer value estimated at $3.50 per ton.

"4—A further reduction in the residual oxygen demand of the tank effluent can be accomplished by aeration; preliminary tests indicating as much as 50 percent.

"5—Chemical treatment of pea-cannery wastes without removal of the coagulated organic solids prior to mixing with municipal sewage does not materially lighten the burden imposed by such wastes on city sewage-disposal plants.

"6—The treatment will materially reduce objectionable stream pollution and prevent local nuisances often caused by untreated pea-cannery wastes."

Isopropyl Alcohol Replacing Ethyl Alcohol in Britain

IN Great Britain a prohibitive tax on ethyl or grain alcohol is leading to the wide use of isopropyl alcohol as a solvent in cheap perfumes and flavoring essences. For this purpose isopropyl alcohol is preferably blended with ethyl alcohol, thus reducing the cost of the solvent and also helping to avoid the odor of isopropyl alcohol which is stated to be heavy and persistent when used alone.

Isopropyl alcohol is made in Great Britain from acetone and this process has given it a reputation for freedom from offensive after-odor on evaporation. In the United States, isopropyl alcohol is made from petroleum and is said to be less free from odor than the British product.

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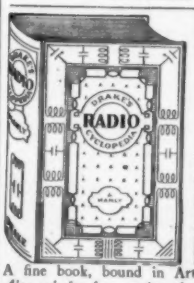

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What color was the dodo?

What common American bird has become extinct in recent years?

How do you determine the horsepower of an automobile?

Unless you score 100 per cent on those easy ones you simply must get the October issue of the Scientific American. You don't want to wonder what it's all about, do you, when someone says, "What do you think of Ernest Flagg's radical building plan for crowded cities?" or when the host asks, "Would you advise me to have my car put through the Lockwood test?"

Like every other issue of the monthly "spokesman of science" the October number of the Scientific American is filled with interesting and valuable facts you need to know. So important is it, in fact, that you had better not run the risk of missing it on the news stands. Better subscribe.

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Dentist Thrives on Troubles

HERE is a rather whimsical letter from a dentist who took up amateur telescope making. Not everything happened strictly according to Hoyle, but nevertheless, judging by his letter, he seems to be sticking to it like a bulldog to a root. When a man starts a job and finds everything so dead easy that his resourcefulness is never put to it to figure a way out of a hole, the work generally loses interest. Haven't you found it so?

Editor, SCIENTIFIC AMERICAN:

Yours of recent date, asking if I recall expressing interest in "make it yourself" telescopes received. I do recall it and a lot of other things besides, among them being that I ordered my copy of "Amateur Telescope Making" before they were off the press, and had to wait with what patience I could until it came; that it seemed as though my glass disks would never come; that I thought I would die of old age before I found out where to get my pitch; that I made several pitch laps for one reason or another, etc., etc., etc. . . . I am still polishing and expect to continue. My mirror has turned out to be hyperbolized to a record-breaking extent, has a turned-down edge, ingrowing toenails, small-pox and I don't know what else, but with care I expect it to pull through. One thing rather troubles me though, and that is that the habit of walking around barrels is getting to be so firmly fixed that I can never get to the office at all on ash-day without the use of almost super-human self-control.

I wish to thank you for all you have done in starting this work and opening a door which seemed to be closed to most of us.

Sincerely,
Dr. E. M. Ryder.
Brewster, New York.

Wherein We Are Told "Why"—

THE response of our readers to the question as to why they like the SCIENTIFIC AMERICAN, asked in our May issue, has been gratifying. Being only human, we like and appreciate a little praise once in awhile, especially when it is in the form of that given in the letters which we publish below. As to the letter from Mr. Wier we would like to say that there is no disgrace in being a "scientific low-brow," as he chooses to call himself. The mere fact that he is interested in science, and anxious to progress, is sufficient indication that he is hardly all that his own term would seem to indicate.

Editor, SCIENTIFIC AMERICAN:

In your May issue, you invite readers to tell why they like the latest issues of the SCIENTIFIC AMERICAN better than the older ones. While I am not an old subscriber, my subscription dating from last Christmas, when one of my boys made me a present of it, and I cannot therefore, make much of a comparison, still I can tell you why I do like the magazine.

As to the regular departments, I like those dealing with radio and aviation very much. "The Month in Medical Science" is extremely interesting, as are also the articles entitled "Inventors Who Have Achieved Commercial Success." In recent issues, the story about flint as the "steel" of prehistoric man and the one dealing with the plague of mice in California were of absorbing interest.

Many thousands of your readers may, like myself, be looking for light entertainment, hence the pages "From the Scrap-book of Science" are always a pleasure. I never pass a picture like that of the four-wheeled motorcycle, nor that of the method of changing a flat tire, without giving it my strictest attention.

You may say on reading this that "that guy is a scientific low-brow and does not know what's what in science." That is just what I am, but since this is a free country, I can be just that and offend no one.

Altogether, I must say that the SCIENTIFIC AMERICAN is entirely worth while, and that there is not a dull page in it.

Yours truly,
William S. Wier.
Atlanta, Georgia.

Editor, SCIENTIFIC AMERICAN:

In your "side-column" page, under the heading "Why?" you ask for letters from readers old and new regarding "trends" or "changes" that may have led them to buy the SCIENTIFIC AMERICAN more regularly within the past year. I hardly

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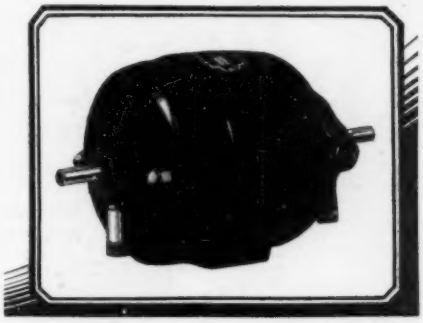

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know whether I may be classed among the new or the *not* new readers; perhaps more definitely as one "returned to the fold." I am a chemist, and some years ago, in the library of a du Pont laboratory, I used to look through the SCIENTIFIC AMERICAN occasionally, but for the most part I found it dry and not much to my liking.

But somehow in the last year or two I have had a revival of interest, even in chemistry, and suddenly I discoverd that the SCIENTIFIC AMERICAN brings before me a review of the very subjects I like, and brings them in a way that pleases, inspires, and sends me out revived for further work.

I have liked the photographs of the men following your "side-column" page. I do not remember that these were previously there. Then, for some reason—I cannot explain why—the style of the articles seems different. Dr. Edwin E. Slosson, Henry Fairfield Osborn, and a few others, in recent years, have had something to say about "humanizing" science, and even the physicists, chemists, and others, have brought more *rhythm* into their writings, and no doubt this has been reflected in your pages. I am of the opinion that you have added something more of expression to your paragraphs along with science, and, after all, it is poetry, art, rhythm, that holds—along with truth. Truth, of course, is science.

Then something else has happened in the world. Science becomes supreme. Mr. Millikan, with the electron, may have done much to interlink rhythm, research, and prayers, and all sides are satisfied. There have long been those who were afraid of the "material" sides of science. But now those who pray for rain more likely find their prayers answered by proper applications of definite laws—perhaps an irrigation ditch or a hose fastened to the corner of the house.

The newspapers have taken more interest in things chemical, physical, biological and the rest. This has come largely through better distribution of laboratory news—mainly I believe through *Science Service*. As people have read more of all that science is doing, they have been led to the publications of science and one of easy access is the SCIENTIFIC AMERICAN. At least this has been the effect with me and no doubt with others, too.

I, of course, subscribe to the publications of the American Chemical Society, but as for a summary even of chemistry, I find the SCIENTIFIC AMERICAN well on top. Then there are the other sciences that the chemical journals do not always touch, and the SCIENTIFIC AMERICAN helps one out of the woods.

Changes are coming rapidly. Radio alone has sent great numbers of people to the scientific journals. Then, discussions of the possibilities of changing mercury to gold—with also the very certain assurance that wood may be changed to rayon, coal tar to dyes, and coal to gasoline—have sent new devotees of science to the scientific literature.

Stories of wealth lead us on. Science has become in large measure the rainbow's end. Whatever it is we work for, we find assurance that science will help us on the way. If it is health we ask, we find promise there, and if it is friends, home,

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Yours very truly,
G. Warren Bryan.
Salem, Massachusetts.

Editor, SCIENTIFIC AMERICAN:

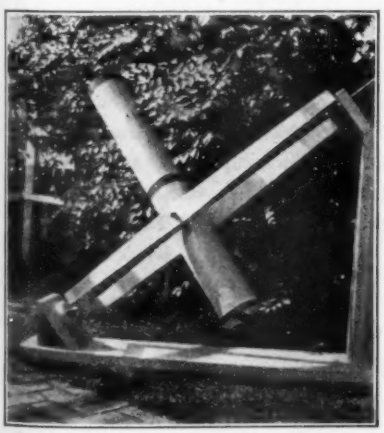
This is in reply to your inquiry "Why?" in the May number. As a subscriber might look at it, it may be that the people are becoming more interested in mechanics and science, due, perhaps, to the many automobiles and motor boats that are being used, thus creating a desire to know what "makes the wheels go 'round."

Then, too, I think that you have been getting a little closer to your readers by talking to them as though you were in the same circle, or sitting about the round table, instead of standing in the rostrum and talking "over their heads," as it were. Editors should "get next" to their readers as nearly as possible, and make us feel that we are almost acquainted with them.

Louis F. Drake.
Buffalo, New York.

Another Amateur's Telescope

IN addition to the letter from a dental surgeon who has made a telescope, we reproduce in these columns a photograph of a telescope made by Mr. Earl O. Graff, of 2340 Granite Street, Philadelphia, Pennsylvania, from instructions contained in the SCIENTIFIC AMERICAN book, "Amateur Telescope Making" (two dollars, postpaid). Mr. Graff omitted to describe his instrument in detail. From the illustration we note that the mounting is of the double



Mr. Graff's telescope with its double yoke, wooden mounting, an easy type to make, and remarkably steady

yoke type. This type of mounting was also used for mounting the great 100-inch reflecting telescope of the Mt. Wilson Observatory. While it does not permit the telescope to be pointed at a small area near the celestial pole, owing to the obstruction of the axis itself (unless the mounting is made portable), this type is noted for its steadiness and simplicity. Says Mr. Graff:

(*Continued on page* 284)

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"I am inclosing a small photograph of my telescope. It is portable in order to permit its use to the best advantage, since I live in an industrial neighborhood and the usual drawbacks of smoke and haze are present, not to mention a large tree in the yard next door."

Bad News for Mosquitoes

HAVE you heard yet of the "mosquito fish," gambusia, a little minnow-sized chap that lunches on the larvae of mosquitoes ("wigglers") until he can hardly wiggle himself? It begins to look very much as if Dr. David Starr Jordan, fish expert and former president of Leland Stanford, Jr. University, really "started something" when he undertook to spread before the world at large, through the columns of the SCIENTIFIC AMERICAN, the news about gambusia's gluttonous appetite for mosquito larvae, for people are now introducing them in many places.

Professor Jordan writes that "those who inquire about buying gambusia would do well to write to William F. Hildebrand, United States Bureau of Fisheries at Washington. There are," he continues, "several state commissions that have stock for supplying their own states."

We asked Dr. Jordan what efforts had previously been made to introduce mosquito fish. It appears these efforts had been pretty largely confined to the scientists themselves. But the SCIENTIFIC AMERICAN bridges this gap between professional scientists and laymen and extends such things to the public. Here is Dr. Jordan's letter: (the reason he refers to the mosquito fish as "meek" is, that they are tiny and able to live in all sorts of surroundings, for example, ditch water, gutters, marshes, et cetera.)

It is said that "the meek shall inherit the earth," and I know of no fish meeker than our little gambusia, which is now spread from Macedonia around to Argentina and to the Irawaddy. Dr. Massima Sella obtained a lot of them after our experiment in Honolulu and planted them near Cadiz in southern Spain. From Cadiz a delegation was taken to Italy in 1922 and placed in four ponds near Ostia at the mouth of the Tiber. From Ostia they have now been taken to 59 other localities, mostly in Italy and some in Jugoslavia, Macedonia, Albania and Palestine. From each of these places good reports have come. A few sceptics are doubtful of the acclimatization of the species—in these cases *gambusia holbrooki*—but they need not worry.

There is a movement in Texas to sell "bat houses" nicely fitted up to accommodate mosquito-eating bats, but no bat nor a thousand bats can keep up with the demand. Paris green in ponds is also sometimes recommended, but enough of the poison to be effective would also kill fishes and maybe cattle which drink from most ponds.

I had not given gambusia much publicity before I wrote to the SCIENTIFIC AMERICAN.

David Starr Jordan.

[Note: See SCIENTIFIC AMERICAN, May, 1926, pages 296 and 297, "Malaria and the Mosquito Fish."—The Editor.]

Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

The Law Protects a Secret Process

THE rights of a manufacturer to the exclusive use of a secret process are well set forth in the recent decision of the Federal Court for the Southern District of New York in passing on a motion in an action to restrain the Momsanto Chemical Works from using the Tower Manufacturing Company's secret process for manufacturing paranitraniline.

According to the evidence, the Momsanto Chemical Works secured the secret process from one Groggins, who, when in the employ of the Tower Manufacturing Company, had agreed not to disclose the process to anyone. Having worked out an improvement of the process, Groggins disclosed it to the Momsanto company, and later went into its employ.

"I cannot think that the fiduciary obligation of one bound not to disclose a secret process, or not to use such a process that has been improperly disclosed, is not violated where the process employed is used to produce an identical result in ways directly suggested by the disclosure, though slightly differing from it in detail," says the court.

"The question is one of the real scope of the secret process and the closeness of approximation of the variation. Such a matter can only be determined on the trial with all the evidence before the court.

"If it appears that either the original or the improved process as properly construed has been obtained by the defendant through disclosure of Groggins in defiance of his contract, it might make no difference that either process was a part of the prior art because there would be an estoppel as between these parties which would prevent the defendant from questioning that the process was secret and would prevent its use by the defendant.

"I can see much similarity in this respect between a secret process and a patent.

"The outstanding difference is that a patentee has a monopoly as against all the world, while the owner of a secret process has no right except against those who have contracted, expressly or by implication, not to disclose the secret, or who have obtained it by unfair means."

The Law of Equivalents

"WITHIN the patent law the substantial equivalent of a thing is the same as the thing itself; that is to say, 'if two devices do the same work, in substantially the same way, and accomplish substantially the same result, they are the same, even though they differ in name, form or shape.'

"Again, old ingredients known at the date of letters patent granted for an invention consisting of a new combination of old ingredients, if also known at that date as a proper substitute for one or more of the ingredients of the invention secured by the letters patent, are the equivalents of the corresponding ingredients of the patented combination."

The foregoing clear statement with regard to the law on substitution of equivalent devices or ingredients in a patented combination is made by Judge Reeves in the Western Missouri Federal District Court. The Johns-Manville Company, Inc., brought a suit for infringement against R. V. Aycock Company. The patent involved was for a novel gas-proof roof or cover for a storage tank for crude oil. In finding for Johns-Manville, the court says:

"Plaintiff's patent was to prevent evaporation and leakage, whereas defendant's structure was to prevent evaporation. By plaintiff's patent it is sought to confine the gas that may arise from the oil within the tank, whereas the defendant seeks to prevent its arising. Each, however, indicates a purpose to make the covering gas-tight as nearly as may be. The defendant contends that oiltank tops cannot be made entirely gas-proof and that therefore the covering processes should be with a view to prevent the formation of gas.

"The defendant has merely changed the character of sheathing adopted and used in practical operation by plaintiff. The claim does not limit the combination to the use only of metallic sheathing but is broad enough to cover any agency, ingredient or mechanism which would answer the same purpose. Defendant says it does not use the metallic sheathing. Let that be conceded, but the fact is that it employs a sheathing of a different material which serves the identical purpose as that served by plaintiff's

Patents Recently Issued

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Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

ELECTRICAL GENERATING APPARATUS FOR AIRPLANES—Capable of operation by passing air currents for the production of electricity for future use in operating the propeller independently of the gasoline motor. Patent 1634167. G. A. Wilson, Greenwood, Miss.

Pertaining to Apparel

NECKTIE AND LINING THEREFOR.—Having resilient or elastic lining which is freely stretchable laterally and is provided with means for permitting a limited longitudinal stretching. Patent 1634032. H. Leoni, c/o Super-Rubber Lining Corp., 1674 Broadway, New York, N. Y.

Chemical Processes

CHEMICAL COMPOSITION.—For whitening, filling and weighting linen or other fabric materials without causing rust stains, which comprises sodium perborate, cornstarch, sodium triphosphate, aluminum sulphate, Epsom salts and denatured alcohol. Patent 1633213. J. F. King, 506 W. 148th St., New York, N. Y.

Electrical Devices

ANTISPLASH DEVICE FOR STORAGE BATTERIES.—Which may be readily applied and removed, and will prevent splashing over of storage batteries when being rapidly charged, or being carried. Patent 1633407. A. Halikman, c/o King Tire Co., 125 W. 67th St., New York, N. Y.

ELECTRIC GASOLINE GAUGE.—For indicating the quantity of liquid in a remotely arranged tank. The device is safeguarded against explosion, for use in connection with tanks of different depths. Patent 1634165. W. E. Williams, 108 King St., Savin Hill, Dorchester, Mass.

DIAPHRAGMLESS MICROPHONE—In which a mixture of course and molecularly fine coal dust are employed as a filling material in a vibration-free receptacle to such a height that the sound waves of the lowest frequency occurring are completely absorbed. Patent 163210. E. Reisz, c/o C. Fehler & Co. S. W. 61 Belle-Allianceplatz 17, Berlin, Germany.

Of Interest to Farmers

WEEDER.—An implement for cutting and gathering weeds in newly plowed ground, the device is provided with a means for dumping the cut weeds. Patent 1631733. M. D. Kast, Box 978, Walla Walla, Wash.

COMBINED FROST-PREVENTING AND IRRIGATING DEVICE.—Having adjustable nozzles, for supplying a fine spray to prevent trees or plants from injury by frost, or a substantial flow for irrigating purposes. Patent 1632611. R. H. Lloyd, Hastings, W. Va.

Of General Interest

BED ATTACHMENT.—By which the occupant of a bed can operate the device to raise himself to any inclined position, or a sitting position. Patent 1630453. T. B. Smith, 101 East Anaheim St., Wilmington, Calif.

reconstructed and altered metallic covering. The rule is that alterations or changes that are merely formal do not constitute any defense to a charge of infringing a patent for a combination."

The Iron Age of Trademarks

THE recent refusal of the Patent Office to register on the application of the Defender Manufacturing Company, Inc., the trademark "Iron Clad" used on sheets, pillowcases, towels and handkerchiefs made of textile fabrics, in view of the previous registration of the same notation by the Franklin Manufacturing Company for use on cotton piece goods is but one of the many reminders that we are living in what might well be termed "The Iron Age of Trademarks."

A few years ago "Irontex," "Iron Sox," "Iron Clad" and "Iron Thread" were all involved in the same action. A. V. Victorius, Inc., sought to register "Iron Sox." R. H. Macy and Company immediately entered an opposition, asserting that the purchasing public would confuse it with "Irontex," already registered by the department store. It developed, however, that the "Iron Clad" brand of Cooper, Wells and Company and the "Iron Thread" of M. and C. Mayer had both been registered before Macy's mark.

In the brief of the attorneys which led to dismissal of that action, the following statement illustrating the use of the word "iron" in trademarks was made:

"The combination of the word 'iron' with 'sox,' while it might be considered to mean iron socks, is strictly a coined and fanciful word having no meaning in the arts and conveying no meaning to the purchasing public. It cannot be held to be descriptive, as the Patent Office is practically estopped from considering it so by the registration of 'Iron Thread,' 'Iron Clad' or 'Irontex' for hosiery, all of which are equally as descriptive as applicant's mark.

"The fact that the word 'iron' is registered as an element in each of the registrations of record clearly shows that the Patent Office did not consider the word either descriptive or deceptive in connection with which it is used, and has practically adjudged each registrant entitled to the use of this word."

Here are some of the trademarks in the knit goods and textile trades showing the word "iron." They illustrate how popular it is:

"Iron Brand," "Iron Clad," "Iron Crown," "Iron King," "Iron Man," "Iron Master," "Iron Mountain," "Iron Pier," "Iron Shod," "Iron Sox," "Iron Strength," "Iron Thread," "Iron Trail," "Iron Wear," "Ironall," "Ironbound," "Ironclad," "Ironhose," "Ironman," "Ironite," "Ironknit," "Ironox," "Ironproof," "Ironrock," "Ironsides," "Irontex," "Ironwarp," "Ironwear," "Ironweave."

The "Factory-to-You" Slogan

THE Federal Trade Commission is hot on the trail of "manufacturers" who have no factories. One of them recently ordered to mend its ways is the Big G Furniture Works, operated in New York by Jacques Greenberger and Carrie Greenberger. An order has been issued barring further use of the slogan "Direct from Factory to You" and the continued use of statements to the effect that the prices at which they offer furniture for sale are factory or manufacturers' prices.

In issuing its cease and desist order the Commission says:

"By means of large signs and in their newspaper advertisements and business correspondence, according to the Commission's findings, the respondents have for more than three years represented that they were the manufacturers of the furniture in which they dealt and that their furniture was being sold to the public at manufacturer's prices, when the truth is that neither of respondents have ever had any connection with a furniture factory but bought their stock as retail dealers and sold it at retail prices.

"The Commission's findings conclude that the respondents' representations of their business and furniture deceived the purchasing public, injured respondents' competitors and were unfair methods of competition."

ACCOUNT SYSTEM.—Whereby accurate records of accounts can be kept without the necessity of the usual forms of day book and ledger. Patent 1630840. W. M. Fredenburg, 30 Cayucos Road, Paso Robles, Calif.

GUM MASSAGING AND CLEANING DEVICE.—In the nature of a pair of tongs, for gripping a roll of cotton in such manner that it may be readily applied to the gums. Patent 1631790. T. A. Buckley, 80 Carlyle Ave., Yonkers, N. Y.

CLOTHESLINE HOLDER.—Wherein it is only necessary to insert the free end of the line in a fixed support, the weight of the line increasing the clamping action. Patent 1632616. G. J. A. Molique, 2712 Deiver St., Granite City, Ill.

CHECK VALVE.—Adapted to prevent flow of pressure fluid in one direction and to permit a limited volume of pressure fluid to pass in the opposite direction. Patent 1632636. A. P. Treadwell and J. Flournoy, c/o Atlanta Chemical Co., One-O-One Building, Atlanta, Ga.

DRIVING BIT.—For race horses, wherein means are provided permitting the driver to prevent any side movement from a straight course, while guiding in the usual manner. Patent 1632589. J. S. Bristol, 214 W. 85th St., New York, N. Y.

EYEGLASS-CASE FOLDING AND PROTECTING DEVICE.—Which obviates the scratching or breaking of the lenses, retains a cleaning cloth protected from grit and provides a personal identification. Patent 1633417. D. W. Perry, 47 Mechanics St., Keene, N. H.

LIQUID-SOAP DISPENSER.—Capable of being operated to discharge predetermined quantities of liquid soap repeatedly, the parts may be readily disassembled for cleaning, but are leak-prook. Patent 1633448. W. N. Lurcott, c/o Moore Bros. Co., 154 Chambers St., New York, N. Y.

PLOTTING DEVICE.—For indicating or displaying in a diagrammatic manner certain conditions, capable of use in a law court for establishing or denying points in a trial. Patent 1633402. J. B. Furber and K. L. Rankin, National Bank Bldg., Linden, N. J.

FOUNTAIN PEN.—Having a supplemental ink reservoir contained in the usual pen cap, for use if the pen runs dry where no ink is available. Patent 1633433. H. Boyer and M. Klevins, 320 Fairmount Ave., Jersey City, N. J.

DETACHABLE-HEEL CONSTRUCTION.—Arranged to permit a dealer in boots or shoes to readily provide a leather or rubber heel, as desired by the customer. Patent 1633449. M. Mayorowitz, 1564 Longfellow Ave., Bronx, N. Y.

CAP FOR CONTAINERS.—Easily and quickly operated with the finger or thumb, providing a closure plate for use on standard collapsible tubes having standard caps. Patent 1633420. W. Schlayer, c/o Fred Schlayer, 9027—77th St., Woodhaven, L. I., N. Y.

FASTENING DEVICES.—Which have a wide range of utility but are primarily adapted for securing dust covers to the upholstery of automobiles. Patent (Reissue) 166660. D. I. Reiter, 100—5th Ave., New York, N. Y.

LIQUID APPLICATION.—A compact protected container from which iodine or other liquid may be readily dispensed from a single hole in small quantities. Patent 1633424. E. Themak, 419 E. 157th St., New York, N. Y.

MAP HOLDER.—For holding a road map in a position to be readily viewed by the driver of an automobile, the device may be attached to the windshield. Patent 1632856. A. O. Running, Dallas, Wis.

INK DISPENSER.—For printer's ink, effectively protecting the ink against evaporation when not in use, and manually operable to dispense ink in any quantity.

Do Not Give Premature Publicity

MANY an inventor has failed to obtain a patent, or if he succeeds in obtaining one, has seen it declared invalid because he unwisely gave publicity to his invention before he took steps to assert his rights to a patent monopoly. Such was the case with Louie Klima, whose design patent for barn ventilator had been assigned to the King Ventilator Company.

When the King Company sued the St. James Ventilating Company recently in the Federal Court for the Minnesota District, it developed that during the years 1913 to 1918 the King Company made and sold large numbers of ventilators of the design in suit except that they lacked a flared base. The patentee, when manager of the company, was author of the publication, widely circulated in 1913, which described the ventilator practically the same in appearance and design as that of the design in suit but lacking the flared base.

Prior to 1919 the patentee had been associated with the Queen Manufacturing Company at which time they had been making cupolas and ventilators with flared bases.

"The evidence shows that Klima, the patentee of the present suit, cannot claim any contribution except that he combined with the flared base, which was old, this superstructure above the flared base, which was old, in both configuration and ornamentation," says the court in invalidating the patent.

"The design law was intended to encourage the decorative arts. It therefore deals with appearance of the thing designed, rather than with its structure, uses or functions. But in a design patent, as in a mechanical patent, the subject matter must be novel, and must have called for an exercise of the inventive faculties.

"In order that there may be novelty, the thing must not have been known to anyone before. Mere novelty of form is sufficient."

IRONING BOARD.—Of simple, durable and practical construction, carrying a readily adjustable means for receiving and holding different sized collars, folded shirt cuffs, or other articles. Patent 1633403. F. D. Gorman, 136 E. 40th St., New York, N. Y.

PHONOGRAPH REPEATER.—Readily attachable to any phonograph of conventional form for actuating the stylus to automatically repeat the playing of a record indefinitely. Patent 1632477. H. House, 403 Pender St., W. Vancouver, B. C., Canada.

ROADWAY EMBANKMENT.—Formed from spaced longitudinal reinforced concrete walls, extending across a canyon or the like, the walls being adapted to retain earth filling which carries the roadway. Patent 1633211. E. A. Jenjs, Alderpoint, Humboldt Co., Calif.

POWDER PUFF.— Having a filler which will hold the walls against caving in or becoming uneven, yet will be flexible and will eliminate bulkiness. Patent 1634175. J. J. Cosin, 133 W. 21st St., New York, N. Y.

BUILDING BLOCK.—Equipped with a metal guard which will prevent the passage of ground-nesting termites from the ground to the super-structure. Patent 1634157. R. L. Morris, c/o Smith & Wild, Honolulu, Hawaii.

BIRD HOUSE.—Adapted for use singly or in colony, having a special nest-bottom which retains a large percentage of moisture from atmosphere, yet repels vermin. Patent 1634209. O. C. Reiber, West Webster, N. Y.

POODLE-DOG DOLL.—An inflatable toy having an outer surface simulating a poodle dog or some other natural object, which may be made to stand or sit. Patent 1634189. R. L. Henry, Imperial Hotel, Broadway and 31st St., New York, N. Y.

ASTRONOMICAL DEVICE.—Whereby the approximate position of the moon relative to the earth, and the earth's shadow and the moon's shadow may be determined any hour during the day. Patent 1634207. D. Phillips, Daytona Beach, Fla.

COUPLING.—For a hose, with means for securing the same so that it cannot be accidentally or otherwise disconnected, applicable to water, steam or gas hose. Patent 1634153. G. C. Long, 1126 Pacific St., Brooklyn, N. Y.

Hardware and Tools

SANDING ROLLER.—Which may be used for receiving sandpaper, emery paper, or buffing material, in sanding or polishing articles to shape or finish the same. Patent 1631798. G. H. Davol, 1953¼ Argyle Ave., Hollywood, Calif.

TOOL FOR WRAPPING WIRE.—Of durable construction, and which greatly simplifies and facilitates the various operations incident to the forming of wire joints or splices. Patent 1633401. J. Fisher, Wabash, Ind.

WRENCH.—Capable of readily supporting itself upon a pipe after being placed in connection, and easily manipulated by one unskilled in the use of pipe wrenches. Patent 1633455. R. L. Murphy, Miera, New Mexico.

CHAIN LINK.—For attaching a chain to an adjacent chain, more particularly cross tread members of tire chains, may be readily attached without the use of tools. Patent 1633434. W. J. Bryan, 11 Bentley Ave., Jersey City, N. J.

HINGE.—Especially for use in connection with screens or storm doors, whereby they may be easily attached to or removed from the casing, without tools. Patent 1633916. F. Zoufan, 1911 So. 51st St., Cicero, Ill.

HINGE.—Which will move relatively on ball bearings, and will be more securely imbedded in the material of the door and the jamb. Patent 1634181. E. Flagg, 111 E. 40th St., New York, N. Y.

Machines and Mechanical Devices

METHOD AND APPARATUS FOR MIXING PULP.—For use in mills using a combination of wood pulp and sulphite pulp, the pulps being automatically mixed and kept in agitation until used. Patent 1631762. W. E. Rosebush, c/o Inland Empire Paper Co., Millwood, Wash.

MACHINE FOR CORING AND DERINDING FRUITS.—Especially grapefruit, conveniently operated without the necessity of handling or touching the meat of the fruit, and in a manner to preserve the appearance. Patent 1631854. J. R. Carroll, c/o A. C. Baurelie. Box 3428. Philadelphia, Pa.

BOBBIN FEEDING MECHANISM FOR LOOMS.—Adapted to automatically thread the shuttle simultaneously with the feeding of a bobbin, so that every movement is utilized for placing filling threads between warp threads, Patent 1631828. J. Lucas, c/o Briesen & Schrenk, 50 Church St., Hudson Terminal Bldg., New York, N. Y.

EXHAUST SYSTEM FOR PAPER-MACHINE DRIERS.—Which will efficiently remove the moist air from adjacent the driers while permitting new air to take the place of the moist air. Patent 1631833. W. E. Rosebush, c/o Inland Empire Paper Co., Millwood, Wash.

POWER-TRANSMISSION DEVICE.—For transmitting power from the fan belt of an automobile motor to a rotary polishing head for polishing the car or any other purposes. Patent 1631500. A. S. Newmark, c/o Path Finder Mfg. Co., 131 E. 23 St., New York, N. Y.

Pertaining to Vehicles

PROTECTIVE DEVICE FOR AUTOMOBILE FUEL TANKS.—Which in addition to preventing access to the filler opening by unauthorized persons serves to brace the adjacent parts of the car. Patent 1626822. G. G. Hearn, Whighan, Ga.

RUNNER FOR AUTOMOBILE WHEELS.—So constructed that the driver without leaving his seat can move the runners under the wheels for driving over snow and can easily disconnect them. Patent 1627507. J. H. Haynes, 73 Cottage St., Bangor, Me.

SIGNAL LIGHT.—Adapted for vehicles, taking the place of a tail light, stop light or parking light, also for use at street corners, building exits, etc. Patent 1626710. J. E. Wood, 1622 S. Wabash Ave., Chicago, Ill.

ANTIGLARE DEVICE—Which may be worn by drivers driving at night, preventing blinding glare and obviating the necessity of special deflecting lenses in automobile headlights. Patent 1628551. B. L. Noyes, Stonington, Me.

RADIUS-ROD CLAMP—For staying the radius rod to the front axle of a Ford automobile preventing undue stress on the usual retaining nut on the front spring perch. Patent 1627695. S. C. Ewens, Box 163, Springhill, La.

TRACTOR-WHEEL ATTACHMENT—Providing means for automatically effecting the removal of stones and dirt which collect within the channel steel rim of a tractor wheel. Patent 1630950. B. D. Landon, Canton, Pa.

LAMINATED SPRING—In which the load deflection diagrams are in the form of curved lines indicating an increase of strength in the springs as the load increases. Patent 1628371. J. H. Stott, c/o H. J. C. Forrester, Jessel Chambers, 80 Chancery Lane, London, W. C. England.

DIRECTION INDICATOR FOR AUTOMOBILES—Readily mounted in the rear window of a closed car, for a constant signal, and for indicating turns, or other action to be taken. Patent 1629425. R. Wardhaugh, P. O. Box 41, New Rochelle, N. Y.

ONE-WAY MOTOR WAY OR STREET—A concrete street with spaced smooth tracking areas, arranged for parallel lines of traffic at different speeds, and a dead or parking area. Patent 1629782. C. T. Eldridge, Mill Valley, Calif.

SIGNALING DEVICE—In the form of an arm visual by night or day, and operable in such manner that the driver will have free use of both hands. Patent 1629380. M. Goldman and R. Karaban, 277 Pennsylvania Ave., Brooklyn, N. Y.

PASSENGER AND MOVING PICTURE ADVERTISING BUS.—Have the usual appearance of a double deak bus, but constructed to present advertising, or a moving picture, to be seen at a distance. Patent 1627473.—A. Zilbersher, 800 Lexington Ave., New York, N. Y.

TIRE SPREADER.—Whereby the entire length of an automobile tire may be spread open for inspection or repair without removing the spreader from its operative position. Patent 1627500. V. R. Goeller, c/o Mountain Lakes Service Station, Mountain Lakes, N. J.

INNER RECEPTACLE FOR HEARSES—Which will be air-tight, water-proof, fire-proof and a perfectly sanitary receptacle within the hearse for housing the casket. Patent 1628893. W. and A. E. Livingston, 413 W. 2nd St., Hastings, Neb.

VEHICLE WHEEL-GRIP MEMBER—For application to the tires of automobile wheels to prevent spinning on a slippery surface, easily applied even though the wheels be resting in mud. Patent 1629786. C. H. Gunthorpe, Sr., 3132 7th St., Port Arthur, Texas.

CLUTCH CONTROL FOR TRACTORS—Which permits pivotal movement of the turntable frame in respect to the coupling bar without interfering with the operation or control of the clutch. Patent 1629550. H. A. Stewart and F. L. Holt, c/o F. Holt, 309 E. Leanterdale St., Tullahoma, Tenn.

TIRE-VULCANIZING MOLD.—Whereby the water of condensation from steam will be prevented from backing up at the bottom of the mold, and will be drained off and ejected. Patent 1630113. P. DeMattia, c/o Munn, Anderson & Munn, 24 W. 40th St., New York, N. Y.

ACCELERATOR CUSHION—Readily adapted to any accelerator rod or connection, and will cause a more even action in opening and closing the valve of a carburetor. Patent 1630199. G. W. Megnin, Myrtle Ave., Allendale, N. J.

SCARIFIER—Adapted to be quickly attached to a standard tractor, the teeth being movable toward or away from the ground, by manually controlled mechanism. Patent 1629784. G. E. Gilbert, c/o Gilbert Mfg. Co., Stillwater, Minn.

AUTOMOBILE SEMAPHORE SIGNAL—Mounted upon the top of a car, normally concealed from view but adapted to be used as an indicator for "stop" or right and left turns. Patent 1629400. C. C. Lovejoy, c/o Typographical Bureau, Court Sq., Long Island City, N. Y.

VALVE-CORE EXTRACTOR—A simple tool, small enough to get between the wheel spokes, for expeditiously extracting and replacing the cores of pneumatic tire valves. Patent 1630976. J. R. C. Smith, c/o Dominion Garage, Victoria, B. C., Canada.

GARAGE—Adapted to have the length extended, by a swingable section of the rear wall, also preventing accidents should a driver fail to instantly stop his car. Patent 1630553. W. F. Watson, 1171 Milledge Ave., Athens, Ga.

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INDEX TO ADVERTISERS

SCIENTIFIC AMERICAN—SEPTEMBER, 1927

R. Alfisi 281
American Lead Pencil Co 268
American Pipe Bending Machine Co 275
American Sheet & Tin Plate Co 271
American Technical Society 280
American Telephone & Telegraph Co 266

Francis Bannerman Sons 266
Bernard & Heller 268
Black and Blue Print Co 280
Broderick & Bascom Rope Co 269

Chicago Stock Gear Works 268
Cortez Cigar Co 266
Walter Critchlow 275

Dayton Steel Foundry Company 275
Demco, Inc 280
F. J. Drake & Co 277

Ethyl Gasoline Corporation 257

Federal Schools, Inc 272
Firestone Tire & Rubber Company 268

General Electric Company ..... Fourth Cover

Harper & Brothers 284
Hobart Bros 268-276

International Harvester Company 263

Laboratory Materials Company 272
Lambert Pharmacal Company 265
Liggett & Myers Tobacco Company 277
Los Angeles Chamber of Commerce 196

Metal Cast Products Company 281
Metallic Sign Letter Co 280
Metro Electric Company ..... Second Cover

Metro Electric Company 261
William Mogey & Sons, Inc 281
Moore & Company 272
Munn & Company 270-272

Nicholson File Company 281
Norton Company 198

Packard Motor Car Company ..... Third Cover
Pathex, Inc 277
Pierce-Arrow Motor Car Company 259
Portland Manufacturing Company 274
Pratt Institute 277

Ronald Press Company 281-288

William A. Schaerr 266
Schwerdtle Stamp Co 275
Shields Engineering & Publishing Co 281
Simonds Saw & Steel Company 272
S K F Industries, Inc 193
Stephenson Laboratory 266

Taylor Instrument Companies 270
Technical Products Company 272
Timken Roller Bearing Company 194
Treasure Sales Company 280

Unisol Manufacturing Company 268
U. S. Tobacco Company 267

Veeder Manufacturing Company 276
Vilter Manufacturing Company 275

J. D. Wallace and Company 281
Wisconsin Electric Company 279
Wisconsin Motor Mfg. Co 273

Henry Zuhr 281

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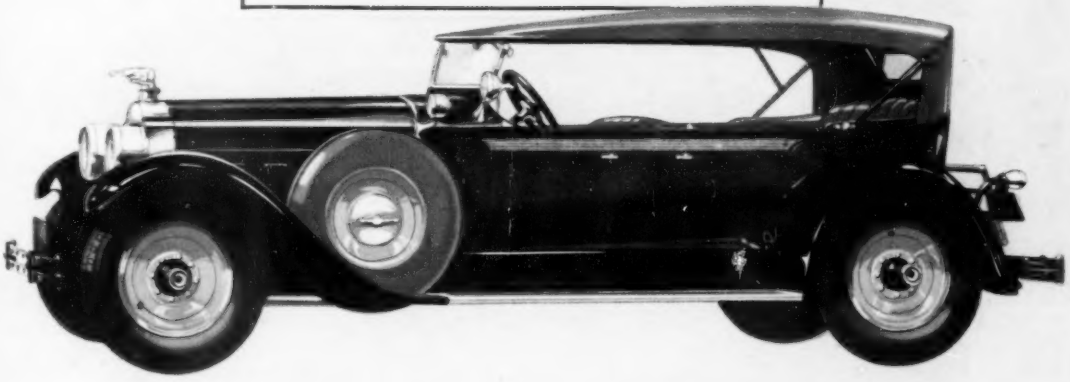

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